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ROYAL COMMISSION ON MATTERS OF HEALTH AND SAFETY ARISING FROM THE USE OF ASBESTOS IN ONTARIO

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VOLUME XXII

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THE FURTHER MATTERS OF THIS INQUIRY RESUMED PURSUANT TO ADJOURNMENT

APPEARANCES AS HERETOFORE NOTED

DR. DUPRE: Good morning, counsel. Are there any matters to raise?

MR. LASKIN: Just one matter from yesterday. Dr. Kotin, you may recall, yesterday in his testimony referred to an article by Whitwell, et al, and Linda Kahn has been good enough to obtain and make copies of that article and I think we should put it into the record, as we intended to do, and mark it as exhibit thirty-three.

I'll just distribute it so that everyone will have a copy.

<u>EXHIBIT # 33</u>: The abovementioned document was then produced and marked.

MR. LASKIN: That's the only preliminary matter I had to raise. I don't know whether any of my friends have any preliminary matters or not.

DR. DUPRE: No? May we proceed then?

I'm very happy today, on behalf of all of us, to greet Mr. Marc Trudeau.

Mr. Trudeau has very kindly returned to offer

DR. DUPRE: (cont'd.) expert testimony as a sworn witness.

Miss Kahn, may I ask you to please swear in the witness?

MARC TRUDEAU, SWORN

EXAMINATION-IN-CHIEF BY MR. LASKIN

Q. Good morning, Mr. Trudeau. Before you get into your formal presentation, could you tell all of us what your present employment is?

A. I presently work for the La Commission de la Sante et la Securite au Travail, a les Direction General la Prevention a les Direction du Programm something???

Q. And what is your position?

A. (French)

Q. Looking at your curriculum vitae, I take it that you were a technical advisor to the Quebec Asbestos Mining Association between 1977 and 1980?

A. Yes, I was.

Q. For the two years prior to that you were a research engineer with what organization?

A. I worked for what is known as the Beaudry Commission...it was a similar commission as the one that is held here...for a year and a half, before working for the Quebec Asbestos Mining Association.

Q. Good. As I understand it, you are generally going to deal with three subject matters in your testimony today. First of all, some problems concerning definitions?

A. Right.

Q. Secondly, problems concerning methods of measurement, and thirdly some concerns and some emphasis on the importance of statistics in this whole question of measurement. Is that a fair summary?

A. Yes, it is.

Q. Okay.

A. I could write that down on the board, maybe, in order to clarify what summary...if you are interested.

Q. Well, why don't you proceed, and if we have to go to the board, by all means. We've certainly got the utensils to do so.

A. But I would like to put the outline there and if questions come after I put my outline on the board, well...

Q. Good. By all means.

A. The first thing I would like to talk to you about today is, I would like to clear up first definitions.

The first thing, we must know what we are talking about, so we are going to talk about definitions - like what is a fiber, what is respirable dust, what is the concept of an aerodynamic diameter, what is asbestos, what is chrysotile. Those are words that need to be defined.

Some words I can help you define, some words I may just say that they need a definition and it's for you to choose what definition you need.

There are also other concepts that need to be defined. One we talk about, the TLV, a threshold limit value. We may talk about time-weighted average, we may talk about permissible exposure limit, a short-term exposure limit, a maximum allowable concentration, a ceiling, or whatever other definition that may that I don't know. But whatever concept that we have to say something about, we have to be clear that everybody understands the same thing, exactly, when we employ the words.

So as an example, if we say a mean, an average, do we talk about an average over an hour, over a day, over a week, or over a year? It must be clear in our mind.

When we talk about the maximum, some people define a maximum as a fifteen minute value, some other people define a maximum as a day, and some other people define a maximum as the

THE WITNESS: (cont'd.) length of the sample, the duration of the sample, and things like that.

So we could go into that for a while.

Then I would like to stress that before...the presentation will be aimed at the measurement first. If you want to talk about anything else than measurement, you may, but I won't make any presentation on other things than measurement.

But when we make measurement, we must be clear about objectives. Why do we make a measurement? Then we set up a strategy and only then we decide to choose an instrument, if this instrument exists. If the instrument doesn't exist, we may choose another strategy in order to find a new instrument, or we might choose to develop the instrument, the technology, so that the strategy that we have chosen is the strategy employed.

So, if you want me to, I could talk about, a little bit more about chrysotile and serpentine, the chemical formula and the crystallographic structure of whatever it is you are interested in.

Then once the definition, the concept of definition is clear, we can talk about methods.

The first point I want to talk about is the membrane filter method, what is known as the membrane filter method, which is analyzed by optical microscopy, and I'll talk more about what I know about the...what is known about the AIA method. AIA stands for Asbestos International Association, and it does propose what is called the membrane filter method, about a year and a half ago. That method there is what is known as the, let's say, quoted best membrane filter method taking all the best from all the other membrane filter methods existing in the world nowadays. Again, here again we can come back to the question of definition. When we talk about membrane filter method, we must know what we are talking about because under one name there are many different methods. There are almost as many methods

THE WITNESS: (cont'd.) as there are laboratories, so indeed there are a few known - like the NIOSH-I, NIOSH-II, the English method, the Australian method, the French method, the AIA method. They are known as a membrane filter measure, but they are different in some respects.

Even within the...in a country where they are supposed to use one method - suppose in the United States where they use what is known as the NIOSH-II method, in each laboratory they have some minor modification that makes the method different.

So we are going to talk mainly about the AIA method. We are going to talk about its precision, and we are going to talk about its accuracy.

Precision is defined as the...how shall I say that... as the propension of a collection of data to be around a number, and the more precise you are, the more the data will be collected around that number.

The accuracy is that number. Is it a just number or is it an unjust number? Just is...that's the French translation for accurate. The accuracy is the number itself, what does it mean?

Here, in the membrane filter method, we are confronting an index of measurement, but also we confront an index of measurement using any method, any method that measures dust numerically measures an index.

That's why we are going to talk a little bit about the transmission electron microscopy method. Again, I say THE transmission electron microscopy, but there are as many as there are laboratories.

But we are going to talk about one transmission electron microscope, the one I know. It's easier for me to talk about that.

We are going to talk about it only for the purpose of showing that it's an index, as well as a membrane filter is.

THE WITNESS: (cont'd.) Then thirdly, these are numerical...let's say numerical. We are going to put by the word fiber per cubic centimeter...there could be fibers per cubic meter or whatever...but let's say numerical. Here we are going to talk about gravimetry and all the other methods that permit people to measure the fibers...not the fibers, but the dust...in milligrams per cubic meter. Here we have first, we could talk about analysis. Analysis is...we could talk about infrared spectroscopy, we could talk about titration.....let's put PH here... we could talk about x-rays. These are analysis methods.

But we could also talk about other methods that involve instrumentation that are available on the market. So we are going to talk about that one. We could talk about the Tyndallometer, and we could talk about the RDM-101.

When we talk about those instruments, we are going to talk first strategy, where are they used.

Then...I do not have enough space...but the third aspect I want to talk about, here also we could say a few words about the fibrous aerosol monitor. These are acronyms because it's less long to write.

We could talk about what is known as the Magiscan, and also what is known as the Vickers instrument. It may have another name, I don't remember.

Okay, can we erase that?

Then the third thing, and I would like to finish with that, we could talk about statistics, and very briefly...okay, we could talk about statistics around a number when we use a method, and when that number is low, what does the statistics that we use mean. What does it mean when we talk about an average.

As you know, an average is a statistic that is used when we have a normal distribution. We are going to talk about distribution. We may talk about the median, which is a statistic used when we have a log normal distribution, or we may talk about

THE WITNESS: (cont'd.) a geometric mean, or we may talk about what they call a Sichel-Estimator.

I am not a statistician, but I know those statistics are used when we have a log normal distribution, and the average is used..or the standard deviation...average and standard deviation are used when we have a normal distribution.

So we are going to look at the kind of distribution we have when we talk about fiber concentration and see what kind of statistics could be used.

The best statistic could be used when we want to use one number to define an area or to...what shall I say...summarize, to compile a lot of data.

So along this, I could start right away with definitions, if you want me to.

Okay, definitions. The first word or concept...I don't know if they are words or concepts anymore, because they carry so much...I would like to define for you is a fiber.

What is a fiber? Fiber may be defined in very many ways, but here we are going to define a fiber as I understand it when we talk about dust, fibrous dust, more than fiber itself.

A fibrous dust to me is a particle that is longer than five microns, shorter than...what we usually use, it's shorter than one hundred microns, but some say shorter than fifty microns is useable also. For the diameter of particles, the AIA method proposes a maximum diameter of three microns to be used as fibrous dust, but the NIOSH method proposes five microns as the maximum diameter.

As a minimum diameter - this is not defined anywhere when we use any method. It's up or down to the limit of detection of the microscope used.

I almost said resolution of the microscope instead of resolution. There is a difference there. The resolution of a microscope is the capacity of the microscope to distinguish between

THE WITNESS: (cont'd.) two objects that are close together, and it's known using green light as it is used in optical microscopy with the membrane filter that the resolution of the microscope is close to point five microns. But the limit of resolution, at the limit of detection, that is the limit where you cannot see anymore any particles, is about half that - point two five microns.

The limit of detection is a practical limit that we measure ourselves, that the technician uses to measure, to see if the microscope, the system of the microscope and themself was behaving to the limit that they could behave, and we have standard slides in order to measure the limit of detection of the system of the technician and of the microscope, and those standard slides...there were two kinds. One kind was produced by some English council. I can't remember the name of the English council, but there were hatch lines on the glass slide, and those hatchings were from various diameters, and at one point the technician couldn't see the hatches, well that was the point where the limit of detection was.

The other slides are produced by a German institute on dust, and they consist of slides on which latex spheres are deposited and those latex spheres, the diameter is very well controlled, and again, it's the same process as with the hatched slides. When the technician cannot see some latex spheres on the slides, then he has reached his limit of detection. In both cases we were measuring about point two five micrometers as the limit of detection.

The latex spheres, I think, to my knowledge, I like them better because they reproduce the membrane filter method.

MR. LASKIN: Q. Just to come back to the diameter point for a moment. When you say the AIA method does not count fibers that have a diameter greater than five microns...

THE WITNESS: A. Three microns.

Q. Three microns, do I take it that that has some relationship to what is respirable and what is not respirable?

A. Indeed. It's thought that, again, what I forgot to say about the fibers is that the aspect ratio, length to diameter, must be also at a minimum of three to one, so it is believed by the AIA that a diameter that is three micrometers in diameter has at least to be nine micrometers long, and it is believed that such a particle is not respirable. It doesn't reach the lung.

Q. Is that because of its length, or its diameter, or a combination?

A. Okay, now you want to get into the...there are, again, two other concepts - respirability of dust and aerodynamic diameter of fibers.

The respirability of dust has been described or modellized by various agencies that have built curves to modellize the interception of the dust by the nose or the bronchii, the dust that reaches the lung, that penetrates the lung, and the dust that not only reaches the lungs, but stays there. There are various curves because they do not modellize exactly the same thing.

The best known curves for respirability are the Johannesburg curve, which is dated 1959, and there is another curve called the ACGIH curve - American Conference for Governmental Industrial Hygienists curve - and those two curves...

Q. Can I just show you your compendium of articles, which is exhibit thirty-four, and if you go to tab four at page 215...

A. Yes.

Q. Are these the curves that you are talking about?

A. Yes, they are. These curves have been modellized for particles, spherical particles that have density one, and that's it. That's at density one. For those particles of density one, it is believed that fifty percent of the dust that is greater than five microns in diameter reaches the lung, fifty percent does not reach the lung. That is according to the Johannesburg curve.

The other curve shows different numbers, but I think...

A. (cont'd.) and here I say 'I think', because I'm not sure about it...but this curve shows about the dust that reaches the lung and stays there, and it's another model.

Q. Which curve is that?

A. It would be...here it would be the ACGIH curve, but again, this is...again, this is better defined in the texts that have presented those models. They are only models that the dust separators tried to accommodate or they tried to fit when they want to collect respirable or nonrespirable dust.

But here I would like just to have a few words about the aerodynamic diameter, because you were talking previously...the first question you asked was about the diameter or the length.

Well, the aerodynamic diameter is another concept that is defined, that has been brought up in order to help in the definition of respirable dust. It's not a definition of respirable dust. It's only a way to, a means to compare - like an orange with a banana. What settles first? It's a concept of sedimentation in air, an aerodynamic diameter. It is the measurement of the sedimentation rate of a spherical particle.

Now, to answer your first question about diameter and length, it is believed that the diameter of a fiber is more important, very much more important, than the length when we talk about the sedimentation rate of those fibers.

In fact, there is a formula...I think it's somewhere in that text..we have the aerodynamic diameter is proportional to the diameter to the first power, but is proportional to the length to the one-sixth power. So that is only...readily in the formula we see that the diameter has much more to it, to affect the aerodynamic diameter.

But again, to go a little bit further than the aerodynamic diameter, it has been proposed recently...and I saw that in a paper, I read this...I think it is described here on

A. (cont'd.) page 216 of the same paper here, of exhibit number four....we come to the impaction diameter, knowing that the particle before reaching any...I am tempted to say lung, but let's say any medium here, has to turn very often and it carries inertia and it may settle otherwise than predicted by the aerodynamic diameter.

This is one paper I saw two years ago. I'm sure it's in...well, it's a paper by Burke, in 1978.

So that's about it on respirability and aerodynamic diameter. Do you have anything else on that?

MR. LASKIN: I think Dr. Uffen has a question.

DR. UFFEN: Just for a little clarification for those of us who aren't familiar with this. Is that a significant difference between the Johannesburg curve and the ACGIH curve, or are they sufficiently close that no one should worry about the little difference?

THE WITNESS: My point of view on that is that they are sufficiently close. They carry different concepts, but again, when we want to work with those curves to see what...those curves were drawn in order that we build dust separators that would do the same, that would collect the dust as the curve wants us to collect the dust. So there are various dust separators that exist, or as I'm told, allitreaters, vertical allitreaters - cyclones, impacters, vertical impacters. There are many dust separators. They try to modellize those curves, but they modellize it from... since it's a model of a model, and since the measurement is not done in the same way, and since we do not know exactly what goes on in the lung, the models that are built - like the cyclones and the allitreaters - are...if you build a curve or the cyclone, and you don't know which curve it should apply to, you won't know beforehand. But the fact is that when the cyclones were built, the dust separator called a cyclone, which is much...I talk about a cyclone because it's much used here in North America

THE WITNESS: (cont'd.) for other purposes than asbestos dust - for silica dust, as an example. It's believed that the cyclone is a model of the ACIGH curve.

The allitreator, particularly the horizontal allitreator, was built mainly to correspond to the Johannesburg curve.

Now I'm working on memory, but I might say that since we are...since the subject is asbestos dust and since we do not deal, when we talk about asbestos, with dust separators, I really never got into that subject very much...of dust separators.

DR. UFFEN: To clarify this just a little bit, if I made a measurement one way and used the Johannesburg curve, and you did it another way and used the ACGIH curve, would it be important or not matter that we were able to translate from the one to the other? Would it be insignificant or...?

THE WITNESS: My opinion is...and it's an opinion now... I never made the measurement myself or I never saw any data comparing the two, but my opinion is that it would be insignificant, negligible.

DR. UFFEN: Insignificant.

THE WITNESS: This is my opinion.

But again, it might be that somebody really compared that using the two models and saw significant differences, but it never even occurred to me to look at such data since when we measure asbestos dust the separation is not made at the sampling time, it's made when we analyze the dust, because it's a modus of separation when we decide to measure the dust of a certain length and a certain diameter. It's a decision that we take.

First maybe it's a decision that is taken in order of...respecting the respirability of the dust, but it may also be a measurement that is taken in order to measure the, as precisely as possible the index of concentration measurable.

DR. UFFEN: I have another little question, Mr. Trudeau...

THE WITNESS: Oh, yes, absolutely.

DR. UFFEN: It's just to clarify something...

MR. LASKIN: Sure.

DR. UFFEN: You referred to this formula on page 216, of the aerodynamic diameter.

THE WITNESS: Right.

DR. UFFEN: At the end of the formula there is a factor K, called the shape factor.

THE WITNESS: Yes.

DR. UFFEN: Can that shape factor change by a few percent, or can it change by factors of two or three or four?

THE WITNESS: I think...you ask a very good question. The factor K, being a shape factor, I always heard that that factor of K was between one and three, so it's not an order of magnitude difference. But it's significant. Between one and two there is one hundred percent difference.

But why in some cases K is equal to one, and in some other cases is equal to two, I'm afraid I cannot answer that question.

MR. LASKIN: Q. What does it refer to? What is a shape factor?

THE WITNESS: A. Again, to my knowledge, a shape factor would mean...it doesn't mean more to me than it would mean to you - shape factor. Maybe when the dust is a particle shape, spherical shape, the shape factor would be one. But again, if we deal with spherical-shaped particles, this formula as itself wouldn't apply, because this formula is good for fibers, fibrous dust.

Q. Well, for example...

A. What you are asking me, in fact, you are reasking the question that Dr. Uffen just asked - why would K equal one and

A. (cont'd.) why would K equal three.

Q. Can I try just a hypothetical example, and you tell me whether I'm completely off base or...

A. You are going to confuse us completely.

Q. Probably.

A. I'm stumbling around right now.

Q. We've heard, for example, that the amphiboles tend to be narrow, straight fibers, chrysotile fibers tend to be curly fibers. Is that a shape factor that might influence this K figure?

A. It might be, but it just might...you have another explanation that I didn't think about.

Q. What's that?

A. The form itself of the fibers. Like you say, the chrysotile fiber is curly, which is a fact. The amphibole fibers, mainly the amosite fiber, is a straight fiber. It may...K may have something to do with that.

Q. That's the question I was trying to get at. So that that difference is one of the factors that may determine whether the dust is respirable or not?

A. It may, yes.

Q. I...Dr. Uffen may want to follow it up...but just one other question so I'm clear. I take it this aerodynamic diameter, which according to the literature and according to what you have written will determine whether the dust is respirable, depends more on diameter than length, but looking at the formula, length is also a factor?

A. It is indeed a factor, but it's not the main factor. If we had to list factors by importance, the main important factor, most important, would be diameter, and then length is a factor.

Q. And shape?

A. And the shape. If the K factor there is what

A. (cont'd.) you say. Yes, indeed.

But again, I might add or readd, that this formula doesn't contain the idea of impaction diameter, which is a new idea that was brought up in 1978, and I don't know what happened to that idea since then.

Q. I'm sorry to take you away from your topic, Mr. Trudeau.

A. It's okay.

I just want to say again aerodynamic diameter is rate of sedimentation.

So, if we go back to...is it okay about respirability and aerodynamic diameter?

We could talk about that again, about words and defining chrysotile as a fibrous serpentine mineral, and I just want to say, because it's going to become important later, that all the serpentine, they all have the same chemical formula, which is hydrated silicate of magnesium. If you want the complete formula, I could write it down for you, but I'm sure you've read it before.

Q. We've seen it.

A. Okay.

Q. I don't suppose I remember it, but I've seen it.

A. The chrysotile and the serpentine share the exact same chemical formula. They do not only share the same, exact chemical formula, they do share the same crystallographic structure and this also will become important when we try to analyze the dust, separate the serpentine from the chrysotile.

Q. Can you just briefly describe what that structure is?

A. Surely. Now, I'll use a model, because it's... okay, all the serpentines are layer shaped crystals, and it's a layer like a piece of tablet paper. One piece is the magnesium layer, the other piece is the silica layer, and then the

A. (cont'd.) magnesium layer, and then another silica layer, and one on top of the other. That's true for all the serpentine.

Now, for the chrysotile fibers...

MR. LASKIN: I think Dr. Mustard is suggesting we might benefit from the blackboard.

DR. MUSTARD: No, no. We have the material there.

MR. LASKIN: Oh, that's right. At long last.

THE WITNESS: Okay, here we have...what is seen as white here is the fiber. What is seen as greyish-black is a serpentine. There is other things, other minerals than serpentine in there, but it's mainly serpentine, and the serpentine called lizardite, and it's not fibrous.

So the only ore that is in that piece here is the fiber that should be on your right. On your left it's the nonfibrous lizardite.

So here, when we describe chrysotile, we have a layer of MgO, and for those who know about, a little bit about crystallography, it's octohedrons of magnesium oxide and under it there are tetrahedrons of silica. As I draw the silica layer shorter than the magnesium, so in order that it fits together, it bends. Here the liaison is by the water, the OH that are in the formula.

So it bends, and bending like that are layered together. Now, let's suppose that this here is a model of that, so all the layers bending, we get what we call the fiber, and this is a chrysotile fiber.

Now for lizardite, because there is a little bit of substitution here, maybe potassium or calcium or whatever, or aluminum, and here because there's a little bit...not much, maybe traces of aluminum replacing the silica, the layer is as big...the down layer is as big as the top layer, so the serpentine doesn't have the tendency to curl. That's the explanation, a quick

THE WITNESS: (cont'd.) explanation of the difference between lizardite and chrysotile.

Now, in between the two there is the one that doesn't know if it should bend or if it shouldn't bend, and that's the antigorite that goes that way.

So that's about it for the serpentine, and I wanted to talk briefly about that because it gives us, when we will talk later about gravimetric measurement of the dust and about infrared spectroscopy and x-ray diffraction, this property of having the same chemical formula and this property of having the same crystallography structure will be less problem. In fact those methods here in Quebec...here in Canada...cannot be applied because we have chrysotile and serpentine dust. Or if they can be applied, it's applied with great difficulty.

MR. LASKIN: So...sorry, Dr. Uffen. Go ahead.

DR. UFFEN: We were going to ask the same thing. That doesn't apply to crocidolite?

THE WITNESS: No, no.

MR. LASKIN: We were going to ask the same thing.

THE WITNESS: The amphiboles, they are not the same chemical formula and they are not the same structure, so they may be differentiated easily from chrysotile. I don't recall the formula of crocidolite or of amosite, but being...and also the reason for the fibrous shape of the amphibole is totally different.

Here we talked about structural reasons. The amphiboles? It's a nice color for crocidolite, anyway.

DR. UFFEN: Not enough royal blue.

THE WITNESS: The amphiboles, and that's mainly... here we are going to...we could talk about all the other, what all the other fibers that consist of asbestos. There are fibers that are not asbestos at all or that are not amphiboles. I've seen a paper produced by McGill University, and Neil went there a year or two ago, and he showed that there were more than one

THE WITNESS: (cont'd.) hundred minerals that could respect the definition of the fiber that I gave before. But when we talk asbestos, we talk mainly of serpentine and amphiboles, and all the other asbestos - that is crocidolite, that is amosite, which are the two most important amphiboles - but there are others, like anthophyllite, tremolite, actinolite. They are all the same, again, similar structures. Not the same crystal structures. They are differentiable by x-ray diffraction and they are also differentiable by chemical analysis. They do not have the same chemical formulae. But the reason for them to be fiber shaped is by cleavage. They cleave, they break, and the particle breaking, it breaks and it gives you a fiber, and that's the reason why they exist as such, as fibrous shaped.

There are, again, many amphiboles that break without giving a fibrous shape. The amphiboles consist of a very large group of minerals.

MR. LASKIN: Q. What accounts for the fact that they are straight?

THE WITNESS: A. Again for the...crocidolite is not straight. I'm happy that you asked that question that way, because I couldn't have said why crocidolite is not straight. I can't say to you why amosite is straight, because if amosite... suppose that is an amosite fiber...by the way, just for the record, amosite stands for Asbestos Mines of South Africa, I guess, but all minerals finish with 'ite', okay, and 'amos' is because it comes from South Africa.

When you want to bend that particle...suppose you want to bend it...it won't bend. It would break and you are going to have two particles, and that's the reason why if they are straight, it doesn't bend.

Q. Now, what about crocidolite?

A. I don't know. It has probably some property, chemical or structural property that permits it to bend, for a

A. (cont'd.) reason that I don't know.

DR. UFFEN: The one noticeable difference so far has been that crocidolite has a sodium atom, whereas the amosite and actinolite don't, if I remember correctly. Could it be that?

THE WITNESS: No, no. It's not that simple.

Crocidolite is a member of what we call the solid solution of minerals, from one end to the other. Now you are getting me into mineral names that I don't remember, but it's a solution between something like riebeckite and something else, and in between you have the chemical formula which, in that chemical solution, all the minerals will have the same crystallographic structure and changing, like replacing a sodium for a potassium, and if you have just a little bit of sodium, it's one name, if you hav little bit more, it's another name, if you have more and more and more, it's another name. But it's within a solid solution.

Amosite is also within another solid solution, and in fact the amosite, when it is not produced as an asbestos fiber, it is called grunerite. And the grunerite is one M of... or not one M, but in the middle of a solid solution between cummingtonite and some other mineral.

DR. UFFEN: The point I was getting at is this substitution in the amphiboles of a bit of sodium, or a little iron and so on, does not do the same thing as the little bit of substitution in the chrysotile, which takes the bend out?

THE WITNESS: No, exactly. Because here the reason for it to be a fiber is a cleavage reason. It's a physical reason of the solidity of the link between layers and the amphibole structure. Like, when you break it, it breaks as a surface. You might...everybody here might have played with mica in the past. Well, the mica always breaks on the same surface because it's easy, the links or the bonds between the elements on that surface are very weak, so it's easy to break.

Well here, the bonds are not as weak, but they are

THE WITNESS: (cont'd.) weaker than elsewhere and the particles, so that's...they break on these planes and they make nice long, straight fibers.

But here in Canada, we don't deal with this. We don't deal with it at all.

MR. LASKIN: Q. Can you take chrysotile one step further and tell us why when you handle chrysotile, at least the evidence we have heard is that it splits up into a lot of very small little fibrils?

THE WITNESS: A. Okay. I know what you are asking.

When we see a fiber, the fiber may look that long. In fact it is not that long. It's very rare that a single crystal of chrysotile is large. It may exist, again, but it's rare.

In fact, when we measure...and again, I'm happy that you asked that question because I'm going to use that fact later to show that even transmission electron microscopy is an index measurement...when we have a fiber, I'll draw it straight even if we know that chrysotile should be curly, in fact what we have is not a single crystal, it's a composite of many fibrils. That's what it is...stuck together.

People that have looked at fibers with an electron microscope, a transmission electron microscope, saw fibrils, but very seldom do people look to fibers with an electron microscope because the preparation of the sample can break that fiber into many fibrils. So from one, you go to many fibrils, and that term fibril is used instead of single crystal, and properly so because sometimes the fibrils are so small they are not even crystals.

A crystal is defined as a unit cell that expands in three dimensions, in three directions, to the infinite. But since those fibrils are so small sometimes, we can't count how many cells there are, and so if we can count, it's not unlimited, it's limited, and it's not a single crystal anymore. Being not a single crystal, it doesn't defract x-rays. It will give the same as glass,

A. (cont'd.) a diffuse pattern. Again, it's another problem when we try to x-ray those fibrils. They do not give a pattern even if they could respond to the chemical formula of chrysotile and correspond to the definition we gave before, they will not give an x-ray diffraction.

So that's...does that answer your question?

Q. I think it does. Just so that I understand it, you are saying that a fiber of chrysotile in fact is made up of a small number of fibrils?

A. Not small number.

Q. A large number of fibrils?

A. A large number of fibrils, yes.

Q. When you look at the fiber on the optical microscope, you see the fiber and not the many fibrils?

A. What you see on the optical microscope is the large fiber...well, the fiber that is as soon as it is larger than point two five microns, you see it.

Q. Right.

A. As soon as it is thinner than point two five microns, it goes by unseen with the optical microscope.

Q. All right.

A. Again, the optical microscope...I'll go into that right away..?

Q. No, I don't want to take you out of order, but just quickly, I take it that if you are taking that same sample and preparing it for the electron microscope, what you suggested is that in handling it and preparing the sample you are likely to break up the chrysotile fiber into those many small fibrils?

A. I did some experiments myself with asbestos, with chrysotile, in water. I never saw myself a fiber. I always saw fibrils. It may be that some other researchers have seen fibers and not fibrils, but there are very few of them. They all report, because in the water it seems that all the diameters

A. (cont'd.) are the same and it's close to point zero one to point zero two microns......when you look at the fibers with an electron microscope, so it's a long way from being observable with optical microscopy.

But again, I'm concluding now, but I'll come back to it later, when we measure with an optical microscope, we measure an index. Yes, indeed, because we cannot see all the fibers.

But when we measure with an electron microscope we also measure an index because we do not for sure measure the same thing that was present in the volume of ore that we sampled - because of the preparation.

Okay, so we've got into chrysotile, we've got into amphiboles. I didn't know that I was to get into amphiboles, but we got into it.

But again, how do we define asbestos? To me asbestos is a processed mineral, a processed fibrous mineral that is processed for some means, and the means the producers know why they process the asbestos, they process it mainly to produce for manufacturers of asbestos cement, shingles, and whatever.

But when we encounter in nature a fiber, I don't think we can call it an asbestos fiber. It's a grunerite fiber, it's an amosite fiber, it may even be a chrysotile fiber. A chrysotile fiber in nature, if it's not processed to become asbestos, to me it's chrysotile. It may even become dust, but then it's not asbestos dust, it's chrysotile dust. It's not the same.

The asbestos has a commercial meaning to it, and when it's not a commercial fiber, it's not asbestos. That is according to my definition.

So that's all I have to say about these few words. If you have other words that we could try to define together, we could go into them, but I would like right away, in fact, to go to the concept of standards. Like, here in Canada and in Quebec,

A. (cont'd.) specifically, because I am more accustomed with the Quebec regulations. We deal mainly with the TLV's, the American definition of threshold limit value as defined by the American Conference of Governmental Industrial Hygienists, and the TLV concept is interesting except that nowadays it comes with so many definitions that we don't know what we are talking about when we are talking TVL's.

Previously, when I first started in that field, we were talking about TWA's - time-weighted average, and the time-weighted averages were thought to be eight hour...they were defined on an eight hour basis day, forty hours a week, and the average was taken over eight hours and corresponded to a forty hour week.

Nowadays, this concept of TWA might still be true, but again, people still work forty hours but they work on the basis of four days or three days, and this TWA concept is difficult to apply for certain contaminants.

For asbestos it may be applicable because asbestos is believed to be a long-term contaminant, not a short-term contaminant. But for short-term contaminants...and now I'm getting into another subject, but I'll get out as fast as I get in...but if we talk about lead contaminants or metal contaminants, well the retention time is being less and we have to define the standards differently than before just because the work organization is different nowadays than it was in previous times.

But now I'm just talking about TWA's, but there are...

Q. I just wanted to ask you one question. Is one of the implications of what you've just said that if you have a particular TLV, whatever it is, one, two, that two fibers per c.c. based on an eight hour time-weighted average may mean something quite different than two fibers per c.c. based on a four hour time-weighted average?

A. It does mean something very much different, for

A. (cont'd.) sure. Here for eight hours the difference is not so much, but if you talk about from eight hours to forty hours, to a month or a year, or forty years, then the difference is very high. You are not talking about the same thing because you are not talking about...you are not defining your standard the same way, and again, now we are talking averages.

We are going to come back to averages later, but we could talk about short-term exposure limits, which are fifteen minutes maxiumum. But again, some people have talked about maximum allowable concentration, which we don't know exactly what it is, a maximum allowable concentration.

Some people use that word and they think about it as the maximum during the sample time, so if the sample time is ninety minutes then the maximum is applicable on ninety minutes. If the sampling time is four hours, there is another definition; eight hours, another definition.

Then there is ceiling value, something else. PEL - permissible exposure limit, that's something else. There is the action level. Again, there's so many definitions that it's very easy to get confused and even industrial hygienists get confused.

I say 'even'. I shouldn't say even, I should say as a matter of fact we get confused...because we have too many definitions and the first thing we should...if we talk about the standard one day, and I believe in my own understanding that this Commission is here to talk about standards, the first thing is to know what we are talking about, and it might be that for asbestos as a contaminant, we need a definition that is different from these definitions because it may be that these definitions don't apply to asbestos dust. It may be that we need another concept of a normative value, and I could suggest things, but the suggestions I could make are only opinions now, they are not expertise. Because the expert that could tell you what kind of definition the people doing work, normative work, in asbestos,

A. (cont'd.) the people that should have a say into that are toxicologists or epidemiologists.

I don't think that an engineer can get into that. An engineer may go and control the dust or measure the dust, but then when we have to make a relation between the dose and the response, we have to rely on epidemiologists and see what they need.

So that's my point for concepts of normative strategies. If you have questions on that, I'll go right away into objectives and strategies.

You do not have questions on that?

Q. I think we'll come back to it when you get to the point about statistics.

A. Okay.

Again, when we measure the dust we may measure the dust pursuing many objectives. If you are in the position of an industrial hygienists that wants to measure the exposure of the worker, you are going to set up a strategy, most obviously, that will permit you to take a personal sample - a personal sample being a sample that is taken near the nose of the worker you want to evaluate the exposure on.

But if you are a dust control engineer in the plant, your objective...it's always to control the dust...the objective of...he has a general objective. But a specific ofjective of the dust control man is to see if the equipment he has in his plant, manufacturing or mining plant, to see if it behaves well and if the dust control equipment is performing well.

But for sure that man will devise a strategy different from the personal sampling. He will probably devise a fixed-station sample strategy, or a...how shall I say...I know it's not the right expression, but getting-to-the-source-of-dust strategy, or whatever strategy he could use.

When we come back later to the definition of

A. (cont'd.) instrumentation like we talked about in the second part of the talk, I want to talk about APM's and Tyndallometers, and RDM's. We are going to talk about those instrumentations, introducing them with the strategies for which they were devised, and we are going to start with saying what we want to do with those instruments.

So that's it. Again, if you are...now I talked about the industrial hygienists in the plant, I talked about the engineer in the plant, but if you are the manager of the plant or you are the chief of the union of a plant, you might be interested in some other ways of expressing the dust count. You might be interested in what we call the dynamic or geographic dust sample, which describes the plant as a whole with one number or two numbers, and it's very significant for the manager to see if the engineers that work under him do their job well enough.

There are various objectives. We could talk about that or any other objectives.

Q. Let's start with the industrial hygienists whose job is to take a personal sample and measure it. The traditional instrumentation recently, I take it, is the membrane filter method?

A. Yes, indeed.

Q. Can you tell us, from your own judgement from working with that instrument, what its advantages are, what its disadvantages are, in terms of its use in the workplace?

A. Yes, I can. First, the membrane filter is not an instrument, it is a method. It is a method that goes back to sampling, preparation of the sample, and to analysis.

It is, to my knowledge, a very interesting method precision-wise and accurately-wise to measure the index of the exposition of the worker. Now I'm talking of the exposition of the worker...or exposure, what do you say?

Q. Exposure.

A. To talk about the exposure of the worker.

It gives an index, yes, but it is an index seemingly that satisfies the epidemiologists. The epidemiologists I've read and the epidemiologists I've talked to in the various meetings I went to and discussed with them, were satisfied with the membrane filter method as an index of exposure, in order to measure the response.

Now, when we talk about the membrane filter method we must talk about one method and not many methods. I introduced before that the membrane filter method is a series of methods, and it goes back to 1969, when it was first proposed, and it was totally, but very totally, a different method than what is proposed nowadays, or what are proposed nowadays, instead of 'is', because nowadays, again, still, in many countries...and some countries have even two different proposed methods. Like, the United States, it might be clear for the industrial hygienists in the United States, but to me it's not clear. They must use what is known as the NIOSH-I method or the NIOSH-II method, and in the England they have their own method. I've forgotten the name of it. I can't recall what it is.

In France they have their own method. In Australia they have the Australian Department method, and those methods, they all are called membrane filter. But some use the thirteen millimeter filter, some the twenty-five, some the thirty-seven, some will sample at the one meter per minute, some others at two, some others at one point seven. Some will use a different liquor of preparation. In NIOSH it's a mixture of what is two organic liquors called dimethyl phthalate and diethyl oxalate, in England it's triacetin, in Australia it's a mixture of acetone and triacetin, and whatever. Then the criteria, once the sample is mounted and ready for analysis, it may be that everybody measures fibers longer than five microns and which have a diameter less than three microns, and whatever,

A. (contd.) but again, sometimes...not sometimes, very often we get into the problem of clusters and of split fibers and of a fibril for one fiber, and the criteria then must be a little bit more specific. What is proposed by most organizations is a catalogue coming with the method, that the technician using that method must learn in order so that many technicians will be... the thing is to make the method as precise as possible.

Q. Let me tell you our problem...

A. I'll go back to my exhibit four, if you have something on that.

Q. Yes. Excepting the various methods within the method, which you have just told us about, some of which may invite more or less precision and uniformity and so on, can you just - taking the membrane filter methods and putting them all into one - can you tell us just generally what the advantages of that method are, along with the optical microscope? What the advantages of that method are in the workplace, and what disadvantages?

A. Yes, I can. But first, you said...if you put all the membrane filter methods together and you do the best of them, you get what is called the AIA membrane filter method.

I don't present it personally. This is a method... yes, it is indeed.

Q. That's your tab ten.

DR. UFFEN: Tab ten.

THE WITNESS: Well, in fact I would like to...I was a member of a committee that wrote that, but I didn't write it myself. There was a committee...if you find at the end in the acknowledgements, the people that helped write that method, very closely...everybody in the acknowledgement helped writing that method. They all considered it as a draft, and they all sent comments to the people which have an asterisk before their name, or after their name, and those people were responsible for the actual writing.

THE WITNESS: (cont'd.) It recollects everything that was best in the various membrane filter methods.

MR. LASKIN: Q. And it's the one you recommend?

THE WITNESS: A. It is the one I recommend, indeed. Yes.

At one point...this is about one year old..and I think for a reference method, it is the best method available because it's adoptable universally. Many countries, or many industrial hygienists in many countries have agreed that this method was giving the data that was needed in order that the epidemiologists...and now I'm answering your question...that epidemiologists get the answers they need in order to make a dose-response relationship.

I would highly recommend that method not only for the sampling strategy - it's a very, has a very lengthy paragraph or chapter on the sampling and the strategy of sampling, and what do they mean as for precision and accuracy. The techniqe is the best technique that we could find compiling all the other methods, the technique of preparation, and the evaluation the same.

But, to go back to your question, with this method we believe that we can get...with the membrane filter method we can get into a precision or a coefficient of variation, a statistic that is mostly employed or used here, and I don't know if it's the statistics that we should use, but we are going to get into that later, because the coefficient of variation is the caution dividing the...so, anyway.

I hope my English is correct. Is it okay?

DR. UFFEN: Superb.

THE WITNESS: But I have the feeling here that I translate French into English, word by word, anyway.

Okay, the coefficient of variation, that is the standard deviation over the average, and later on we'll see what

THE WITNESS: (cont'd.) an average is and in what limits an average has, and you will see that maybe it's not the best way to express a collection, compile a collection of data, especially when we talk about dust.

But we believe at the AIA, even with all the limits the coefficient of variation has, we believe that we could reach within one laboratory up to fifteen percent coefficient of variation, and within many laboratories we would hope, after we exchange permanent slides, point two five micrometer...twenty-five percent coefficient of variation.

The coefficient of variation may come from...the difference may come...if we use only one method and it's really that one method, we could go back to table six point two of my exhibit number four, on page 222. If we use many methods, then we have to collect together table six point one and table six point two in order to explain the differences between the techniques.

One other advantage of the AIA method is precisionwise it's going to be very easy to get a high precision between technicians, because the slides are made permanent. So we could exchange them between technicians for a very lengthy period, and even the same technician in order to show that he didn't go into a trend in a year or two of experience, he could have to measure the same slides a year or two after he measured it at first, and control the quality of his measurement over the years with those permanent slides.

By the way, the NIOSH method does not permit the permanent slide because the medium of the liquor medium, when it dries, it forms crystals and the crystals that are formed happen to be fibrous. So they are difficult to distinguish with the real fibers. This problem does not occur with the AIA method.

So precisionwise, the AIA method, because the quality control is made easier, I would recommend this.

Now, accuracywise the membrane filter method is

A. (cont'd.) an index, as we told before. It measures the fibers that are larger than point two five microns. We have to live with that index, so much that the epidemiologists think it is the index that we should measure.

Again, another reason why we should use the membrane filter method is...and now I'm going to quote one of the members of the dust measurement advisory panel when we had meetings two and three years ago...this panel is still going on, but I'm no longer a member since I do not work any longer for the QAMA... but that member was Jerry Chase from Johns-Manville, and they used to ask, is it better to get a little bit of information very often or is it better to get a lot of information seldom.

To us, that question was selfanswering, since a little bit of information very often carries more information than much-seldom. I might add that the much-seldom, when we were talking about that we were referring to the transmission electron microscopy, and this brings me...now I'll give you another reason by comparison why we should use the membrane filter method with optical microscopy, instead of the transmission electron microscopy. It might be a negative argument, but it's an argument that weights a lot, and it's double - two arguments in one.

The first argument is that if you ask a transmission electron microscopist to set up an analysis for one single sample, he is most probably going to charge you close to six hundred dollars for every sample he is going to process because the sampling is tedious. The preparation of the sample is very long, and the analysis is even longer and more tedious.

Also, he has to pay for the capitlization of his instrument, which costs a lot of money.

Q. Can you give us...

A. I'm sorry...

Q. I was going to ask you to compare the time it takes to do a sample with electron microscopy as opposed to...

A. I was coming to that, Mr. Laskin.

First, I never went into the actual cost of an analysis with the membrane filter, but I believe it ranges between ten and fifteen dollars per sample. It depends always on the number of samples you have to do, if you have a large volume or a low volume, but if your laboratory is set up for membrane filter analysis and sampling, ten to fifteen dollars per sample would make sense.

What was your question again?

Q. I just wanted you to give us some idea of the time comparison.

A. Okay. Well, with membrane filter methods it is possible for somebody to take a sample in the morning, a ninety minute sample, to get it prepared in the morning, to analyze it in the morning and get the result right away at the end of the first part of the shift. It is possible to do that with the AIA method.

Usually...now I give you the minimum time...usually what is done, the sample is taken one day, mounted right away, measured the day after. That's usual...a twenty-four hour basis is closer to the actual practice, but if you are in a rush, you may do it within four hours.

Now, for the transmission electron microscopy, the sampling time may be the same, but then when you get into the preparation, you have...I'm going to describe for you as an example and I just want to be fair, it's not the only method that is used....the transmission electron microscopy, it's with...as the membrane filter method, it is a collection of many methods, and I know that you have here at the Commission talked to electron microscopy people and I don't know if they told you that every laboratory has its own method of mounting the samples.

I used to mount samples of water for electron microscopy analysis of fibers, and the method I used then was

A. (cont'd.) similar to the Environmental Protection Agency method in the United States. First you collect the fibers on the filter - this is the sampling. Then you come to the laboratory, you ash it on a low temperature asher, and the ashing process takes twenty-four hours. Then you resuspend it, you ultrasonically disperse the fibers in water...again, ultrasonically disperse - I may add that this helps to break the fibers, just as an example here, a digression...this may take something close to an hour.

Then once it's ultrasonically dispersed and refiltered on a nuclipore filter...later I'll make the difference between the nuclipore filter and millipore filter, they are very different. One is a membrane filter, as you know, and the nuclipore filter is a screen filter.

Once the nuclipore filter is ready, then you have to cut that filter to bring it to another laboratory to coat it with carbon or whatever other coating device you have, and this may take another hour or so.

Then you recut the piece of filter you have, you put it on a copper grid, a very small copper grid, the recut part, and you put it under an atmosphere of chloroform for another twenty-four hours.

Then you have a prepared sample after maybe three or four days, if you work fast. When your sample is prepared, you have to make an analysis of it. If you make an analysis straight on the electroc microscopy, you are not going to be very precise because the eyes get very tired looking at the fluorescent screen and you won't see all the fibrils. Even if the fibrils can be seen, your eyes get tired, they get red, you don't see anything, you see particles where there aren't any, you don't see any where there are many, things like that.

So if you look at them readily, it's a process of

A. (cont'd.) five, six, seven hours, but this is not what you want to do because it's not very precise. So what you do is you take pictures of various fields, and the pictures, you may take up to sixty or a hundred pictures - they are called micrographs - and then those micrographs, you examine them in your own laboratory where it's comfortable, where you have a white screen and you examine the micrographs one after the other until you have the number of fibers that you need to make good statistics on the amount of fibers there was previously in your sample. This may take another day or two.

So it's a very long...I gave it in deatail...it's a very interesting method, the transmission electron microscopy method, but it's long, it's tedious. As a matter of fact...

Q. I take it that all that you said applies to the transmission electron microscope, and does it...do you have any knowledge as to whether it applies to the scanning electron microscope?

A. I don't know at all about scanning electron microscopy.

DR. MUSTARD: That's the question I wanted to ask. Has there been much application of scanning electron microscopy?

THE WITNESS: The only knowledge I have of scanning electron microscopy is the knowledge I have from readings. In these readings I never saw data coming from a scanning electron microscope. I always saw pictures. They turn out very nice and great pictures, those scanning electron microscopes, but actually I am not still looking because I didn't look for the last year and a half for data on asbestos dust, but I never saw data collected with the scanning electron microscope. It might exist.

MR. LASKIN: Dr. Uffen?

DR. UFFEN: Could I take the opportunity here to clear up a point about the membrane filter method, so that we don't have to come back to it later on?

DR. UFFEN: (cont'd.) It's a point that I think shouldn't take too long, but I would like to get it tidied.

We have had lots of discussion about the difficulties and limitations of counting the fibers, but the unit is fibers per milliliter or cubic centimeter, so we should pay some attention to the rate of flow measurement, and could you briefly describe how the rate of flow is done, how often is it calibrated, who does it, is it reliable, or does it, too, have large possible errors?

THE WITNESS: All right. There's two answers to your question. I'll just write down the ideas first.

The answer to your question - to my knowledge, again - is yes, the rate of flow is very important. Well, not as much the rate of flow as the speed, the velocity of the flow, okay? It is not the same.

Like, we use here in North America the NIOSH method now as...one of the NIOSH methods, but for that purpose, the two NIOSH methods are the same. They recommend two liters per minute flow, and that flow with a thirty-seven millimeter filter corresponds to a speed at the entry of the filter of about four centimeters per second, and that is the data that is important - that four centimeters per second.

If you are using a thirty-seven millimeter filter, if you sample at a higher rate or at a lower rate, you are going to get a higher speed at the surface of the filter, or a lower speed, and it makes a difference, really. The fibers penetrate more when the speed is higher, into the membrane filter, and it will not be at the same...it will not be as readily observable when looked at with the optical microscope, because the depth of field of the optical microscope is very small. I can't recall how small it is, but it's in microns that we talk about...a few microns...when you talk about depth of field of the optical microscope.

THE WITNESS: (cont'd.) When we talk about the AIA method, we are talking about the rate of one liter per minute, so that we get the same speed at the surface of the filter of four centimeters per second, so that we get similar data. The two methods, they are different, they give data that are significantly different, but not so much as they could be if the two would have a rate of two liters per minute, with a speed very, very high, on a twenty-five millimeter filter.

Does that answer part of your question?

DR. UFFEN: Yes, that certainly answers one part of it.

THE WITNESS: But there is the other part, when you sample, you sample with a pump. The pump is calibrated and the code of practice is that you calibrate your pump before going to sample, and you calibrate after. If there is more than ten percent difference between before and after, you reject the sample.

DR. UFFEN: Does that happen often?

THE WITNESS: Not that I recall, because we keep the sampling time within the limits of the capacities of the batteries. That's why the AIA method becomes interesting, because the AIA method goes first - is a rate less than the NIOSH method, and second, the porosity of the filter, we are looking at a one point two micron porosity instead of a point eight that is used generally, and the difference of pressure is less with one point two - a depth charge we call it - of one point two micrometers, than with a point eight. It was proven that the two filters are equivalent. If we employ them at the same rate and the same...if this parameter is controlled, they are equivalent. So the one point two is less...one point two millimeter porosity is less demanding on the pump, so we might be able to go to longer sampling times with the AIA method.

But those pumps must be not only calibrated for rate, they must be calibrated for damping.

DR. UFFEN: Oscillation.

THE WITNESS: Oscillation.

DR. UFFEN: All right. Just so it's clear to everybody.

THE WITNESS: Again, the pump is very often...most of the pumps that are sold on the market, they work on a diaphragm basis, so it pumps and in fact if we look at the rate of sampling, it's not a continuous line of two liters per minute. It would be like a wave. When it samples, a high rate, and it doesn't sample, and very, very often the pump turns ...I don't know what's the rate of the motor, but suppose it turns at a thousand turns a minute, well there's going to be a thousand diaphragm movements, and that has an effect on the surface of the filter. If it's transferred...if your modus of transferring the pumping to the filter is very, very narrow - you don't have much air between the pump and the filter - this effect is going to be transferred on the filter and the filter is going to start vibrating itself, and even the air after the filter is going to go back and forth and it is believed that makes a great difference...what we call the damping effect.

So it's proposed to buy pumps that are equipped with dampers, or that do not work on the same principle as the diaphragm basis. That damping effect is....we get rid of it by adding a volume of air, a large volume of air, between the pump and the filter so that every...that volume of air is taking all the vibrations or all the oscillating movements giving the damping effect, to get at the filter the regular meters per minute.

It's very important that all the pumps be well calibrated.

MR. LASKIN: Dr. Mustard?

DR. MUSTARD: I have what is probably a very complicated question. We have been...it falls into this question which Dr. Uffen has asked..we have been, I think, informed that fiber length and fiber diameter are very important, and that is a

DR. MUSTARD: (cont'd.) limit in the optical microscope, fiber diameter. Also I think we have been informed that the behaviour of fibers relates to the length and diameter as well, and so I guess one of the things that one is concerned about is that when you are sampling the atmosphere in this manner, are there any fibers that you don't get?

In other words, are you sure that you are sampling all the fibers, and how can we be confident that the dynamics of this whole operation, what goes on the filter, etc., is a true reflection of what is out there in the atmosphere, including the biologically hazardous fibers which the optical microscope method will not detect?

Has anybody sort of put all that together? I don't know you do the careful analysis of the atmosphere to find out what it contains. You can set up experiments, I suppose, and you do carefully controlled electron microscopy to sort of really look at your fibers, but has anybody done that and sort of seen what you really are pulling out is representative of the actual atmosphere?

THE WITNESS: I don't know how to answer your question. I'll try. Maybe if I don't answer your question, just tell me. But the method used when we want to measure the exposure of the worker is a personal sampling. So we put the filter as close as possible to the nose of the worker.

In fact, in the AIA method we define the...what we call the zone of respirability as in a sphere of three hundred millimeter radius, I think, and I think that the center of that hemisphere would be between the ears, so if we set up a filter right on the lapel here of your jacket, we believe that we sample as close as possible to the same air as you would breathe.

DR. MUSTARD: No, no. That's not what I'm trying to get at. Let me try to pose it in a different way.

If we create a cloud of asbestos dust, we know from some of the evidence we've heard with some of the research

DR. MUSTARD: (cont'd.) applications to electron microscopy, the cloud's a broad spectrum of fibers. We've also learned, and I believe you have been emphasizing it, that the optical microscope is limited in what it can measure of that fiber population.

I think I have received instruction that the biological effects of fibers is broader than what you can measure both in length and diameter, than what you can measure in the optical microscope, so as you said, the optical microscope is an index of fibers, but it doesn't tell you about all fibers.

THE WITNESS: The optical microscope.

DR. MUSTARD: Yes.

THE WITNESS: Right.

DR. MUSTARD: Therefore, since it's an index, one would want to be confident that the air sampling deposition on the filter is really giving a good reflection of the total mix of fibers out there so that we could be confident that the index is accurately reflecting the biological hazard as that sample reflects.

I was wondering if anybody had done the following kind of experiments: That you create an asbestos dust cloud in the laboratory, you use the most sophisticated electron microscopy technique - not the ones that create artifacts, but those that could be used using scanning electron microscopy, which will give you pretty accurate measurements...and correlated that to your sampling procedures to see if, in effect, one approach versus another gives you a better reflection of what's really out there.

THE WITNESS: Okay. Well, look, in a volume of air there are various things. The air is composed of gasses, of particles, and sometimes..and we are here for that...sometimes an asbestos dust. Now we don't know exactly the distribution of the length and of the diameter of the fibers in that volume of air. We would like to know, we would like to measure it.

THE WITNESS: (cont'd.) The problem is that with dust and specifically with asbestos dust, it is very difficult, it is so difficult that in my opinion it is next to impossible because every method...the membrane filter gives you an index of measurement, it gives you a very nice index of measurement for all the fibers that have a diameter larger than point two five microns. Because the preparation of the filters is very mild, it's not aggressive - you don't break fibers with that preparation - you cut it, you put it on a slab and it's prepared.

But still it is an index because we don't see them out. We see...we know what we don't see, though.

With transmission electron microscopy, it's even worse...no, not worse, that word is not good.

DR. MUSTARD: I wasn't speaking about the relative merits...

THE WITNESS: No, I just want to...you'll see what I come to. With the electron microscopy, sure we see all the fibers, but the preparation is so aggressive that we may...we may not, but we may..break the fibers into fibrils, so what we measure on the electron...when we use electron microscopy, because of the preparation, is again an index.

I call it an index because we do not see the exact thing that was present in the volume and thirdly, the scanning electron microscope, I never prepared any scanning electron micrscope samples, but I know samples are prepared and if they are prepared again, you make a change in the volume of air you had before.

Even the collection of it on the filter is somewhat attacking the purite of the volume of air that you have.

DR. MUSTARD: I guess the answer to my question is, the experiment has not been done, and the reason why I raised the question is, certainly in reading through the biological experimentation with animals, people have been preparing fiber

DR. MUSTARD: (cont'd.) populations for...reasonably defined fiber populations, and I guess in a sense...it may not be possible to do it...but we really do not have an answer as to how good the sampling optical microscope method is as a measure of a definable population of asbestos fiber, so we have to go on the assumption that it's a reasonable measure.

THE WITNESS: We know that the epidemiologists are satisfied by that.

DR. DUPRE: May I just follow through on one point here and see if it's getting through my dense skull the right way?

Is what is being suggested here that electron microscopy is not necessarily a good means of checking on optical microscopy, for the simple reason that the preparation of sampling for electron microscopy simply alters the dimensions and structure of the fibers that you are going to look at?

THE WITNESS: I would say yes, if you would have said 'may alter'.

DR. DUPRE: May? Okay.

THE WITNESS: Who knows? I've never seen a large fiber on an electron microscope, but it may have happened for that purpose that they were not large fibers in my sample at the start. It may have happened, it may not. I was never curious enough to compare or to sample together membrane filter and electron microscopy, being that I was not working in the research field and even if I raised the question, I didn't bother to answer it.

DR. MUSTARD: Is it worth doing?

THE WITNESS: I would say it is worth doing.

MR. LASKIN: Q. Do I take it when you were doing measurements when you were with QAMA, you didn't use the electron microscope to check to measure your samples that you got with the optical microscope?

THE WITNESS: A. Never. The transmission electron microscope was used only for analysis of the dust in water...not the

A. (cont'd.) dust in water, the fibers in water.

Q. From a technological point of view then, could you take a sample that you measured with the optical microscope, take the same sample, measure it with the electron microscope and come to some conclusion one way or the other as to whether you are measuring the same thing and in fact measuring what the particular worker has inhaled?

A. Yes, one could do that. In fact, two or three years ago I went to the Ontario Research Foundation and I went to meet there Dr. Chatfield, and he had done the experiment himself, comparing TEM and membrane filter, and if I recall well what he had told me then...I never saw any writing on that, but it was a verbal transmission...

Q. Discussion.

A. Discussion...

Q. Discussion amongs the experts.

A. ...and the TEM method was...the electron microscope was looking at many more fibers than the membrane filter - so many more it was several orders of magnitude more.

I don't know if...I think he said to me something like ten to fifty thousand more fibrils.

I didn't ask then the question, did you see fibers. I know he told me he saw more. He didn't tell me he saw the fibers that were seen on the optical microscope. He didn't tell me that he had seen them with his electron microscope. You see?

The distribution of the particles...it's only assumptions, but suppose that we have a distribution of particles like, here would be...let's talk about the aerodynamic diameter. I don't like it so much, but it will serve the purpose.

Okay, with the optical microscope we start at..let's say we talk about some dimension and suppose we talk about the three micrometers with the optical microscope. Now we get everything that is here.

A. (cont'd.) Now, what we would like to get is the rest, but now the rest...this total is how much larger than only this? In fact, we don't know.

What Dr. Chatfield told me, he told me that if I used only this method, I measure...let's say ten thousand times... if he has put that into writing since then, it's probably written somewhere in some paper. I know he's very fluent for...

DR. UFFEN: I think it's buried in our...

MR. LASKIN: The presentation he made to us.

DR. UFFEN: Yes.

THE WITNESS: Anyway, suppose that this doesn't exist. Suppose it goes like this. By preparation for transmission electron microscope, instead of measuring...say this would be the real thing...instead of measuring all this and all this, maybe he measured something like this. Because he breaks them off here, and now they are here, right, and this brings me to the...in fact it's part of the answer to your question...the transmission electron microscope may alter the volume that you are sampling because of the preparation, because this and that are different.

Is it clear as an answer?

DR. UFFEN: Yes.

THE WITNESS: This is an assumption. These are not facts.

DR. UFFEN: It's a hypothesis?

THE WITNESS: Yes.

DR. UFFEN: But reasonable.

THE WITNESS: A reasonable hypothesis, right. But I stress that my little experience with transmission electron microscopy...those particles here I never saw. But they exist, we see them with the membrane filter.

DR. UFFEN: Could I ask a very brief question which is very mundane compared to this? That is, who calibrates

DR. UFFEN: (cont'd.) the flow meter in the membrane method? Who calibrates it and how often does it get done?

THE WITNESS: I don't understand your question, because the flow meter is...the calibration at the start of the sampling, it's the calibrator that's used to calibrate the pump. The flow meter...oh, you are talking about the rotometer within the pump?

DR. UFFEN: I'm talking about the business of letting a little soap bubble flow down through the apparatus...

THE WITNESS No, no, no. The soap bubble thing is something else. The soap bubble, you buy...now we get into chemical apparatus....that I don't remember the name of...viewerette, let's call it viewerette, but it's a large cylinder that is...and the pump, let's say that the pump is here.

So this is marked, this piece of equipment here is a cylinder that has been previously calibrated by some other means in a factory where they produce it, and it is believed that it's very precise. They say up to plus or minus five percent, or less than that even.

DR. UFFEN: Tab ten, appendix B.

MR. LASKIN: Thank you, Dr. Uffen.

THE WITNESS: Exactly it. So that apparatus here comes like that. It's sold by chemical apparatus equipment manufacturers.

DR. UFFEN: And it's called the flow rate calibration?

THE WITNESS: Well, this is called a cylinder and it has a specific name, but I just don't remember.

DR. UFFEN: Who does it and how often?

THE WITNESS: This calibration?

DR. UFFEN: Yes.

THE WITNESS: Everybody, as I said, the code of practice says before and after sampling. That's a code of practice.

DR. UFFEN: Thank you.

THE WITNESS: Usually it's the beginning of the day and at the end of the day. It's a very, very quick thing to do. You can do that in two minutes, its calibrated.

DR. UFFEN: Does the workman do it or does a hygienist do it?

THE WITNESS: The hygienist. It takes a technical man to do it, because it needs a little bit of skill just to bring the bubble that it doesn't make a lot of bubbles, but only one, and just the matter of having a chronometer to measure from here to there and know what it means, and what have you.

DR. UFFEN: A chronometer is a watch?

THE WITNESS: Yes.

DR. UFFEN: You just sit there and watch the bubble and...

THE WITNESS: Time watching.

DR.UFFEN: It was not a big, complicated issue then? It was a simple one? All right.

THE WITNESS: Oh, yes. It is very simple. I hope it is. It might not be. You know, sometimes simple things look simple, but really they are not.

Again, I would like to stress, there are two other things I would like to say. I'm not here to make the case for the transmission electron microscope or the membrane filter. But I am here to make the case that a method is very important to a standard.

In fact, you cannot talk about any number, X, Y, Z, if it doesn't come with a method. This is the most important thing. Whatever method that you may choose to recommend or whatever number you may choose to recommend, it comes with a method. It's the most important thing because without a method, a number doesn't mean anything...the same as that number doesn't mean anything if it's not well understood conceptually as a TLV, or whatever.

THE WITNESS: (cont'd.) I would like to give you an example I saw. A year or a year and a half ago I went to an American meeting of industrial hygienists, and very often people mix up...I saw a nice presentation where the man that was presenting the data was comparing his data with TLV, the American TLV of two fiber per milliliter, not saying that the data collected was collected with and analyzed with a transmission electron microscope.

Well, this is a case that is...it's one example to show that if an industrial hygienist can make such a mistake, it is very easy for everybody to make the same, so it should be clearly stated that it shouldn't be done, and we got into an argument, I remember, because you couldn't...you know, it's like comparing apples with oranges. You cannot do that.

If the two fibers per milliliter was and is a standard now that comes with one of the many membrane filter methods, but still when we talk about those numbers - two, five - it's always closely related to membrane filter measurement methods, one of the many.

Another thing I would like to stress...

DR. DUPRE: Could I just ask you a kindergarten question?

THE WITNESS: Sure.

DR. DUPRE: As I understand what you are telling me, point one is that a particular standard - pick a number - cannot be divorced from the method of sampling?

THE WITNESS: Exactly.

DR. DUPRE: Right?

THE WITNESS: Right.

DR. DUPRE: But at this point I, in my ignorance, have to ask the following question: Is the situation one where, pick your number, whatever it's going to be, and then in terms of

DR. DUPRE: (cont'd.) your method you have a choice as which you are going to use, so long as you always use it consistently, and only use that method in interpreting the standard?

Or are you telling me something different, that with certain numbers go certain methods which you must use?

Am I making myself clear?

In other words, could you use...could you have a two fiber standard, okay?

THE WITNESS: Yes.

DR. DUPRE: And then analyze it by TEM?

THE WITNESS: No.

DR. DUPRE: Provided you always use TEM and did nothing else?

THE WITNESS: Well...

DR. DUPRE: In theory?

THE WITNESS: In theory, yes.

DR. DUPRE: Okay, but you wouldn't do it in practice because TEM is so much more sensitive...

THE WITNESS: Well, not only, but the two fibers as we know it was always meant to be a number...the concept of what you said is true, but your example is false.

Like, two connected with TEM doesn't make much sense as an example because the TEM sees a lot more fibers...like I said before, orders of magnitude higher...than the actual membrane filter. So if you talk about TEM you would have to talk about twenty thousand fibers or fifty thousand fibers.

DR. DUPRE: No, no. That's not what I meant.

DR. UFFEN: Is this another way of putting it? The unit is defined by the method of observation?

THE WITNESS: Yes. Oh, yes. This is my main point. It's a very important issue.

In fact, we talked about the membrane filter method

THE WITNESS: (cont'd.) that exists nowadays, before, but we didn't even talk about the various membrane filter methods that existed before and how the membrane filter method improved in the past, and as they improve, they measure more and more fibers using the same methods.

Like, when it started we used to measure a full field, so the technician would have to scan with his eyes a very large field of measurement. Now he has to measure only a small field using a graticule that was specifically built to measure asbestos, and in between the two they had to go through graticules that were not made to measure asbestos, but measure other kinds of particles - like the Porton graticule which is still used is not the graticule built to measure asbestos specifically. It's built to measure other types of particles.

The only one that exists, it's the Walton and Beckett, that exists and is widely accepted - graticule to measure asbestos dust.

Again, since 1969 when the first standard or the first membrane filter methods were promulgated or were proposed, the optics were not the same as nowadays. The optics are better.

Also, but most important, nowadays the technicians are better trained than before to make a judgement on what they see and what they do not see.

So to my point of view, that's all I have to say about the membrane filter method and TEM. You could go to what I called before by two point two gravimetric measurements...or before going to gravimetric measurements, to wind it up with numerical measurement, if you want to know anything about the fibrous aerosol monitor or the Magiscan or the Vickers instrument, they are all new instruments proposed to the market in order to make a numerical analysis of the fibers, of the dust, the fibers per cubic centimeter.

DR. UFFEN: Yes, I would like to, but would counsel...

MR. LASKIN: That's fine.

DR. UFFEN: One way of going about this is to sort of identify our strategy, you know, why would we discuss this.

What I would have in mind is, are the advances currently being made consistent methods of monitoring and measuring moving fast enough that we should be aware of them so as not to make decisions about procedures or regulations or anything else that might become obsolete because just a few years from now there may be a major instrumental development, as distinct from a medical development?

Now, if you, without going through all the principles involved, could you tell us the relative merits and disadvantages of the FAM, the APM and the PDM?

THE WITNESS: RDM.

DR. UFFEN: RDM, excuse me.

THE WITNESS: And Tyndallometer, maybe.

Yes, I can. I will not talk about the APM and the Tyndallometer and the RDM right away because those are gravimetric instruments.

DR. UFFEN: Oh, all right.

THE WITNESS: But I will talk a little bit about the FAM, as I know it, and the Magiscan as I know it, and the Vickers instrument as I know it.

Those...out of those three, two are only analysis instruments. The Magiscan and the Vickers are proposed by Vickers, it's by Vickers Instrument. The Magiscan, I think it's a company named Joyce and Loebel. The Magiscan was developed in England. Those two, Vickers and Magiscan, they are there to replace the technician that would measure the fibers by optical microscopy.

So they would give the same, supposedly and preferably, they would give results that are conforming to manual results. So if you are preoccupied by obsolescence of the membrane

THE WITNESS: (cont'd.) filter method, the research in that field is not going to make the membrane filter methods obsolete. On the contrary, it's going to make it easier to perform with because it's going to automatize the part that is mostly discussed by the people, it's going to automatize the analysis of the fibers, using the Magiscan or the Vickers instrument.

A year and a half ago, those two instruments were still in the development stage. I don't know where they are at today. All I know is that they were very promising two years ago, both of them, and my personal opinion, if I had to make a choice between the two, at that time two years ago I was liking very much the Magiscan because it was at that time an instrument that would completely replace the technician that makes the analysis, and not only would it completely replace them, but it could, in the development stage, take many, many samples and process them twenty-four hours a day.

But I heard recently that they are still in the development stage two years after I went, and they were..so it seems that to replace a manual count is very difficult, and let's be clear, it's going to give the same...again, I know I repeat myself, but it's for the sake of clarity...it's going to replace the technician, but it's going to give the same results. It has to be calibrated with manual counts. It's very...and the Vickers the same.

They are manual counts and then we calibrate the instrument and we get data out of that.

DR. UFFEN: Could you use, for calibration, a standard slide and then calibrate the Vickers or Magiscan instruments wherever they were, whichever country?

THE WITNESS: Yes, we could.

DR. UFFEN: Then an interlaboratory exchange of data would be facilitated?

THE WITNESS: I guess it would be possible. It's merely a guess because I do not understand that this instrument is not commercially available yet, because two years ago I was told...I even went to visit a place in England where they had a Magiscan installed, and they were on the verge of being ready for commercial sample, and they are not...they seem not to be in fact.

DR. UFFEN: Where was that, do you remember, in England?

THE WITNESS: At that point? At that point they had calibration problems, two years ago.

DR. UFFEN: But who was it or where was it?

THE WITNESS: Oh, it was in Manchester University, it was Dr....I think his surname is Eric, but his name is Taylor, Dr. Eric Taylor. The Taylor part of it I'm sure.

But again, the Magiscan is a very costly instrument and in some workplaces it would still have to be done with manual counts anyway...even if a Magiscan would be accessible, we still would have to work with manual count and we still would have to provide calibrated manual slides.

The FAM is a little bit different from the two other instruments, as it samples and it gives an analysis of the fibers on line. It has many advantages like that. It's an on-line instrument. You get a very fast numerical concentration around where you take a sample, but the inconvenience with it is, there's two types of inconvenience. First, it cannot be used for the objective of seeing the exposure of the worker because it's above the instrument. It weighs at least thirty pounds.

MR. LASKIN: Q. You can't use it for personal sampling?

THE WITNESS: A. Oh, definitely not. It's a thirty pound instrument, it's very heavy, and also it has to be set up on a table so that there is a horizontal plane and a vertical plane on it that have to be respected.

Q. You have to use it for a fixed station sampling?

A. Fixed-station sampling, but again, it has some.. on fixed-station samples we have other instruments, first, that are easier to work with, and the FAM, since it works with very delicate techniques like the laser beam and the electric field alignment of the particles, since it works using these techniques, it's very prone to misalignment. In a factory or a mill where the vibrations are constant, it may get out of alignment very easily and when it gets out of alignment it needs another series of calibrations, and two years ago this created a problem.

Again, nowadays, these defects...what I call...well, these inconveniences, might have been answered, too. But still, if I had to be...if I was a worker in a workplace, as an industrial hygienist, I would not recommend to buy the FAM because it is bulky. Just on that basis, I would not be interested.

So that's all I have to say about...

DR. UFFEN: Could I bring out one point about it though?

THE WITNESS: Sure.

DR. UFFEN: That it's difference from the others, as I understand it, is that it really does measure fibrosity, it measures the fiber because of the oscillation of the electric charges in the electric field.

THE WITNESS: Oh, yes. It's a very nice instrument.

DR. UFFEN: It's very sensitive to the difference between a fiber and a nonfiber, have I got that right?

THE WITNESS: Oh, yes. The principle of that instrument is splendid. It's a piece of art. You know, it impresses someone to look at that instrument and to see how it was devised. It works very well in the laboratory, as I said. It may work very well for a researcher that has to...like we said before...to deal with certain types of, length of asbestos, but it

THE WITNESS: (cont'd.) can even...using the instrument it is possible to make an analysis of the length of the fibers, using the FAM, because there are various positions that if you calibrate the instrument well, you are going to get between two and three microns length, between three and four microns length, between four and five, five and six, whatever you want to do. The instrument is really working well.

The principle is diffraction of a laser beam at ninety degrees from a fiber, and it is received by a cell and this cell examines the amplitude of the message received, and the width of the message received, and with these two components it makes a judgement on the length of the particle that is measured.

Now in order to discriminate particles and fibers, the dust is put in an electric flume and the fibers are made to oscillate. So the beam will oscillate with the fibers as if it is a bulky particle. The beam is present all around the particle, so it will not oscillate.

So there is a microprocessor that is able to decide if the beam has oscillated enough during the passage over the cell, and it discriminates the particles from the fibers very easily.

It seems easy once done. It's to do it that was something.

DR. UFFEN: It's one thing in the lab, but it's another thing out in the shop?

THE WITNESS: It's a researcher's apparatus, it's a very nice apparatus. Again, for an industrial hygienists, I don't know what I would do with it. Maybe I would have a use two years from now for it, or maybe tomorrow, but nowadays I can't think of it.

DR. UFFEN: Does it make sense to combine a discussion of the APM and the RDM together? They both use the same principle of...

THE WITNESS: Yes, but they are used different...

THE WITNESS: (cont'd.) used for different objectives and there are different strategies. We are getting into the gravimetric analysis.

DR. UFFEN: All right.

THE WITNESS: Gravimetric analyses are usually expressed in milligrams per cubic meters. They may be expressed in nanograms per cubic meters, in micrograms per cubic meters, but usually we hear of milligrams per cubic meter.

This part we will divide in two. We will discuss first the...

M. CASGRAIN: Mr. Chairman, if you will permit me, for a number of reasons, including logistics, I was wondering whether we could think now about how we are going to work the rest of the afternoon - plus I have someone with me who must eat at a certain time because of medical reasons, so I was wondering on whether you planned on the length of adjournment or whether or not we are going to adjourn, and so on, so we could finish in time for us who live outside to go back.

DR. DUPRE: Maybe this is something that counsel could talk about.

M. CASGRAIN: It's now quarter to one. I don't know whether you want to go on or adjourn.

DR. DUPRE: Normally, we would go on until one, and start at two-fifteen. But on the other hand, since Mr. Trudeau seems to have just reached another chapter, we could, to permit counsel to put their heads together, adjourn now and come back at two...if this is agreeable.

All right. No objections?

Is that agreeable to you, Mr. Trudeau?

THE WITNESS: Sure.

DR. DUPRE: All right. Let's take our break now and we can reconvene promptly at two, and my understanding is that among other things, counsel will work out their arrangements.

MR. LASKIN: Yes.

THE INQUIRY RECESSED

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THE INQUIRY RESUMED

THE WITNESS: Are we ready to start now?

MR. LASKIN: Yes, by all means, Mr. Trudeau.

THE WITNESS: May I say another additional comment on the membrane filter method, after talking with a minerologist during lunch time - the additional comment I would like to make is that with the membrane filter method you cannot identify the type of fiber that you are looking at, unless you know about it beforehand.

What I mean by that is, if you have a technician that has always worked in the same factory, and he looks at asbestos dust through the microscope, he recognizes his dust, as I may say, very easily. When he is proposed a slide that doesn't come from his factory, he recognizes that it doesn't come from his factory. Sometimes he may know where it comes from. Like, I was very surprised when I worked for the Quebec Asbestos Mining Association that the various technicians, when we would make a round robin with unidentified slides, that they could know where they would come from, or they would say this one, it comes from Bell; this one, it comes from Lake; this one comes from Carrie, or from Johns-Manville, or whatever, and they knew just by the shape of the dust where it was coming from.

But, this is not to say that we can identify dust, the fibers, with the membrane filter. We cannot. For sure if you had not seen the asbestos fiber before, or that type of slide before, you cannot say where it comes from. It's just a matter of experience.

Like, the membrane filter method could not be used

THE WITNESS: (cont'd.) to identify the various types of dust like crocidolite, or amosite, or chrysotile on a very quantitative basis. It can be used with a...a trained technician will, for sure, make a difference between chrysotile and amosite quite easily, because they are not the same. One is straight and the other one is curly.

But it's not obvious that he will be able...the machine, or the method or the microscope is...the word to be used here is, it's not an analytical tool for identification. It is an analytical tool for concentration measurements.

The other instruments that we talked very briefly about this morning are analytical tools. You can identify, to some point, to some degree only - not to all degrees - when the fibers become fibrils, then you cannot identify them more...or you can identify them, but with great difficulty, using the electron microscopes.

Which brings me to say that the electron microscope, as in fact was suggested to me - I must be honest where I take my source from, Mr. Rowlands here - but it is a matter of fact, if you look at the literature, that the electron microscope is always used as a research tool and as an analytical tool for research projects, and not for routine analysis of the asbestos dust.

For reasons that we mentioned this morning, it would be difficult to use whatever, an electron microscope, because maybe...well, we said all the reasons this morning, but one of the main reasons is that at one point you have to choose between a lot of information very often, or a little bit very seldom. Or to put it another way...that's about it.

DR. DUPRE: Let me see, Mr. Trudeau, if I understand the methods fully. It all goes back, of course, to your opening principle that there is a tremendous interdependence

DR. DUPRE: (cont'd.) between on the one hand the kind of method that you are going to use and the kind of standard that you are going to have?

THE WITNESS: Right.

DR. DUPRE: Now, a standard, as I understand it, that was a differential standard, that differentiated between, let us say, crocidolite or amosite on the one hand and chrysotile on the other, is the kind of standard for which the membrane filter method is probably inappropriate?

THE WITNESS: To that point it is true, but when you sample the dust, you know what you have as a first product. If you go in a factory or if you go in the mining business, the fiber that will occur there, you might make the assumption that there, if you are in a chrysotile mine, they are chrysotile fibers.

Okay, maybe one out of a million fibers, or out of a hundred thousand fibers...I don't know how many out of how many, but we make the assumption that they are all chrysotile.

In a factory, the same. If they buy only chrysotile or if they buy only amosite, then we don't have a problem.

You have a problem when you don't know what you are looking at.

DR. DUPRE: Now, let's say for example that we've got an asbestos-cement pipe factory, and let us then assume that it is known that there is some chrysotile, let us say, and some amosite, and some...let's just say that it's known that there is some chrysotile, and some amosite...

THE WITNESS: And let's put crocidolite in there.

DR. DUPRE: Now, this much is known.

THE WITNESS: Yes.

DR. DUPRE: And of course under the membrane filter method you would be asking the individual to try and identify both types. You would not be able to do that?

THE WITNESS: Not with the membrane filter.

DR. DUPRE: Not with the membrane filter.

THE WITNESS: You would not be able to do it with an expectation of precision in an assessment, but I would like here to make a parallel with other methods.

When we sample, like silica dust...when we sample for silica dust, it's a gravimetric standard, but we do not use the x-ray diffraction to differentiate the silica dust from the other type of dust for every sample. We make, let's say, a yearly survey saying that, okay, there's between ten and thirty-five percent silica in that dust in that factory, so we make from then on, for the next year, we make the assumption there is thirty-five percent silica in that dust. Then we weigh the dust. We go from x-ray diffraction once a year to a very routine application of weighing the dust all year round, and that's the way it's done routinely. It could be the same for asbestos.

Once a year, or every two years, or once every amount of time necessary, you make an assessment of the proportion of the type of dust in that factory, and unless there is no change, maybe they will change the recipe to make the asbestos cement, but if there is no change in the product, we might make the assumption that there will be no change in the composition of the dust.

Afterwards, once the proportions are known, you may go with the membrane filter and make the assumption that what you saw, twenty percent is amosite, forty percent is chrysotile and the rest is all the other types of fibers that you may have. That could be well set up, that could be well understood.

It's already set up with silica, anyway.

DR. DUPRE: Counsel, if you would permit...

MR. LASKIN: Sure.

DR. DUPRE: ...if you would hold my hand while I take another step, tell me if you want to drop me or not.

Am I to assume again that the standard that is there is one that differentiates between, let's say chrysotile and amosite?

DR. DUPRE: (cont'd.) I want to understand the interrelationship with that, and the electron microscope.

As I understand it, electron microscopy will enable you to differentiate?

THE WITNESS: I believe, yes.

DR. DUPRE: However, what I should then bear in mind at this point - two things - first of all, the cost of electron microscopy, and secondly, at the technical level, the possibility that you explained on the board there, that of course the preparation may actually be altering what it is you are looking at?

THE WITNESS: True. The second point is, I think, a very valid point, because then you don't know if your proportions are correct.

But the first point, referring to the cost, it's easily...you can go through that very easily because, like I said, the electron microscope would not be used on a routine basis. It would be used only to measure the proportion and not the concentration, the proportion of the dust, and you would need that electron microscope maybe...if you don't change the process...once everytime you change a process. So if you never change a process, it's valid all the time. So you make once an analysis, a complete analysis, and that's done.

DR. DUPRE: That gives you the proportions, and then if you are willing to assume, to make the assumption that that holds, then you could use the membrane filter?

THE WITNESS: That's where you have to make a decision on that. This is a decision that one must make in order to be able to measure the dust, and that kind of decision has already been made with the silica. They say the proportion, the highest proportion they measure in a survey, a complete survey, or they go in a place where it's susceptible to be the most representative place, like a crusher or something like that, in

THE WITNESS: (cont'd.) a mining area.

But yes, indeed, if you have different standards for different fibers, it will create a problem.

There are ways to distinguish between fibers with a membrane filter, but again, the research...there are ways like dispersion staining, which they say that they do differentiate between the different types of fibers. Another way is polarized light. Polarized shows..with the use of polarized light you can see the different crystal structures of the amphiboles compared to the serpentine.

But again, these two I know about because I read in an atlas on them, but I don't know about that.

DR. UFFEN: I asked Dr. Chatfield about that specifically, and he reminded us that the particle size that we are concerned with is too small to be affected with a polarizing microscope.

THE WITNESS: Okay, so if he did try, his word is better than mine. I did not try. I know polarized light is a well known method in minerology to distinguish two types of crystals.

DR. UFFEN: It if worked, it would be quick and fast, and you could do it.

THE WITNESS: Yes.

DR. UFFEN: But he gave us an unequivocal answer, and I'm...I would have to go back and check his words, but it was an unequivocal answer that the particles are too small.

THE WITNESS: This may be a reason, but also the preparation of the sample may have to be different, and when you examine with polarized light, you don't examine with phase contrast. It's another type of illumination, so it would be two different microscopes, or two different settings on the same microscope.

THE WITNESS: (cont'd.) The phase contrast is used to enhance the contrast, so it may be that you see a particle using the phase contrast, and you don't see it using the polarized light. So it's difficult to assess if it's a chrysotile or an amosite, if you can't see it.

But I just wanted to stress that point before starting on the gravimetric.

Do you have a question?

MR. LASKIN: Q. If you use the membrane filter method and you use the AIA method, how much room is there for the kinds of human errors that you refer to in your article, and how qualified do the technicians have to be?

THE WITNESS: A. If we go back to exhibit number four, on page...I think it's page 222...let me verify that. Yes, it is.

If everybody used the AIA method, we get rid of the variation in dust counts that we see in table six (1), because these are variations between various membrane filter methods. So everybody using AIA, table six (1) is not valid. Only table six point two would be valid, and this we can control. Every point there may be controlled. The variation in the flow rate of one pump may be controlled by taking the flow rate before and after and making a decision if there is, as I said this morning, if there is more than ten percent difference between before and after, you reject the sample.

Now, nonuniform distribution on the filter, this we may get rid of also by examining the filter with a low-magnitude magnification.

With this kind of examination if you see...if it's nonuniform distribution for the fibers, it's going to nonuniform for all the dust and you are going to see it right away. Then you can go back if it's okay, and you reject it if

THE WITNESS: (cont'd.) it's not uniform.

Recording of sampling time? Well, this is a matter for the technician of recording the sampling time right. Very often this is...or it was done with a usual watch at plus or minus five minutes. Well, why do it plus or minus five minutes when you can do it plus or minus a second. So this is done, okay.

Contamination: This is a matter of quality control of the batch of filters you buy. You have to examine them. For every lot you buy, you have to examine at least one or two out of twenty to see if there is something on them before you ever sample, and it has to be done all the time because it is often that we see contaminated filters that are bought from the company that distributes them.

The mounting: The quantity of mounting liquid may create the condition of migration of the particles. Well, the AIA method accounts for that because it says two...is it two or three drops using a syringe, and that's the amount of liquid you need, and not more than that. So this disparity disappears.

Counting: This is the main thing that we cannot really get rid of on a short-term basis - the different comprehension of the same criteria by two technicians, and the state of mind of one technician.

These two, let's say human errors, can be at least diminished by quality control using..like we talked about...using the permanent slides we talked about this morning. If a permanent slide goes around many technicians and they give their data to each other and they see they are very different, they are going to ask among ourselves why are we different. So if they are different, they are going to find a reason.

We had started that at the QAMA, to do not only a round robin, but meetings of the technicians to find out how they understood what was going on, and we were building another

THE WITNESS: (cont'd.) catalogue that would be more than the catalogue that is given on appendix H of I don't know what exhibit here, but...

MR. LASKIN: Ten.

THE WITNESS: Exhibit number ten.

So the AIA method tries to...

MR. LASKIN: Minimize.

THE WITNESS: Minimize...convenient with the mounting and sampling errors, and minimize the other error with the quality control of every technician, him with himself, that's his training...

MR. LASKIN: His training?

THE WITNESS: ...on a short term or long term, using that or many permanent slides, and between technicians using the same slides but in another strategy.

MR. LASKIN: Q. Okay, good. What's the next topic?

THE WITNESS: A. The next topic you want me to talk about is..and I'll try to go briefly over it...is the gravimetric measurement.

Q. This is a measurement, I take it, that some other jurisdictions have used to set standards, measure standards?

A. There are jurisdictions that set standards gravimetrically, yes. Quebec is among them. But I'm not going to go into the legal part or the judicial part of it.

Q. No, I don't want you to.

A. It's not my field and it's not the purpose why we used in the QAMA the gravimetric instrument, was not at all in relation to...

Q. Regulations?

A. ...to the regulations. They were in accordance with the, in relation to some specific needs that we had. Some specific, I should say, objectives that we had.

Q. Were they used as just, generally used as engineering control devices?

A. Mainly. Yes, indeed.

Q. That is...all right. Can we just run through that relatively quickly?

A. Well, I'll start by the engineering dust control equipment, or the engineer point of view in the plant.

If you are an engineer in the plant and you are hired there to control the dust and to assign to yourself your priorities of dust control, the instrument you will probably mostly need is what I call the Tyndallometer.

The Tyndallometer is included in the gravimetric instruments, but in fact it gives you a number that is high or low, and it's on line with what you are doing. It doesn't take a sample, it only measures whatever you see.

It's a very light instrument. If you know you had a dust leak because you had a high count, or your APM had a high data, you don't know where the dust leak is because it doesn't show, you can't see it with your eyes, well, the Tyndallometer replaces your eyes. It's more sensitive to dust than your eyes, and it will show you readily where the dust leak is.

If you want to assign priorities in your plant, like between one thing and another thing, you go with the Tyndallometer and you may see how large the number is and you may see that very fast. It's a quick instrument and at the beginning we bought...when I was there still...we bought that for the industrial hygienist in order for him to assess...we got it to assess the permeability of the filters that we were using. Not the membrane filters, but the filters used in the production.

But then the maintenance people discovered that instrument and they went with it, and now they use it everyday to assign themselves priorities.

THE WITNESS: (cont'd.) I might explain to you how it worked, but...

MR. LASKIN: I don't...

THE WITNESS: ...I don't think it's interesting. All you need to know is, it's a portable instrument.

MR. LASKIN: All right.

THE WITNESS: On line, and...

MR. LASKIN: Q. It enables you very quickly to identify a problem and control the dust where the problem is?

THE WITNESS: A. Exactly.

Q. Okay. And it's not a counting device at all?

A. It's not a counting device. It's a device that...we never usedthe data as it was. We used a variation of data - high/low.

DR. UFFEN: I just wanted to establish one thing, however. I believe it has a very large range of sensitivity, that it might be used for heavy dust collection, or very small?

THE WITNESS: Yes.

DR. UFFEN: How small can this thing be used simply as a detector, not as an identifer or a measurer? Can it be taken into a nonworking place, but into an environmental situation and tell you whether you have got abnormal dust?

THE WITNESS: I don't know. I've never tried it.

All I know is, it was very sensitive and sensitive enough for the purpose we had for it - to control the dust...

DR. UFFEN: Just to tie this down, we may be able to kind of get a grasp on it, on page 245 of tab four...page 245 of your article...that third paragraph deals with this issue, and it gave the range of possible concentrations that could be detected all the way from point zero one milligrams per cubic meter up to ninety-nine point nine milligrams per cubic meter.

Could we translate point zero one milligrams per

DR. UFFEN: (cont'd.) cubic meter into fibers per c.c.? Even approximately?

THE WITNESS: These numbers are numbers...first, you have two questions.

The first comment I want to say is that those things that, like the point zero one to ninety-nine point nine, is a number given by the company that sells the instrument, okay? It's the way the instrument is presented or calibrated. But we never used it to measure the milligrams per cubic meters. We were not interested in milligrams per cubic meters, with that instrument, because we did not believe in the measurement.

What we believed in was the variation of measurement. This was out point. That's the first thing.

The second thing, milligrams per cubic meter to fibers per cubic centimeter, there is no correlation. There might be a liaison, a relation, between the two, but no correlation. So point zero one...if there is no asbestos, there might be a lot of dust, but there is no relation with asbestos because this instrument will measure all the dust.

DR. UFFEN: All the dust.

MR. LASKIN: Q. I take it if we go back to page 243 and look at table six point six, at least...you get...that doesn't suggest there is any absolute conversion, but it shows you the kind of side-by-side measurements that some companies have had?

THE WITNESS: A. Yes. This data was taken with the RDM-101, which is an apparatus that we really thought was giving real gravimetric measurements, real...it meant milligrams per cubic meter, the RDM-101. That's why we bought it, and this picture that you see on 614 in table six point six, is the kind of game we would play with the instrument to try to predict not the fiber concentration numerically, and with milligrams per cubic

A. (cont'd.) meter, but to know if we had a problem or not.

Like, here the table says that for gravimetric concentration of close to point eight four, something like that, milligrams per cubic meter, this data here shows that...yes, that's it, point eight five. Well, then, I think it's ninety percent of the time if you have less than point eight five milligrams per cubic meter, you will also have less than five fibers per cubic centimeter.

That's what I recall a relation. You don't know exactly if you have, like, point eight five milligrams per cubic meter, you don't know how many fibers you have. But ninety percent of the chances are that you are going to have less than five fibers per cubic centimeter. You are not interested in the rest. If you are there for standards, you know that you are under the standards - ninety percent chance under the standard - and you go to someplace else to do your fiber measurement.

The RDM...I want to...supposedly we are finished with the Tyndallometer...now we are mixing...

DR. UFFEN: Sorry, it won't take long to tie this down. You have described it as a good, rapid, portable device for detecting changes in the dust?

THE WITNESS: Yes. Very sensitive also.

DR. UFFEN: All I'm trying to determine is, if we took that same instrument into another situation, the renovation of a building, and a worker needs to know whether there has been a big change in the dust, or an inspector does, would this be a good instrument to use for that purpose?

THE WITNESS: If he compares the data with another data. It's used as a comparative instrument for respirable dust.

THE WITNESS: (cont'd.) You don't have to talk about...not for asbestos dust.

Like, if you go on demolition work, if you knew what the dust was yesterday and you want to know if it has changed today, you go with your instrument, sure you are going to see a difference or not. Sure, it could be used for that.

It's a very fast instrument. You would not have to stay for twenty hours there.

In fact, it's an instrument that could be used anywhere where there's dust to show the change in dust...a little bit like the smoke detector is used for ventilation measurement purposes, very positively.

Now, the RDM-101, again it's another apparatus, a portable apparatus, that works on the beta attenuation principle. It gives a data every four minutes, as the ones we employed in Quebec. You may ask the company that makes that machine to give you an RDM-101 that will give you a data every two minutes, four, six, eight. It's decided at the factory.

Even when decided, you may change it at your place, but then you have to make a manual calculation. If you want it automatically, it's...you need it from the factory.

But anyway, the RDM-101 is mainly used, again, for engineering purposes, and it's used very often in relation to, close relation with the numerical analysis in order to show beforehand if we might have a problem numerically.

We go with the RDM-101, take a few measurements, and we see what kind of dust we are going to have, using it. This was the purpose, the objective we were pursuing was to assess a problem quantitatively as fast as possible, and then assess it with a fixed-station sample numerically. This is standardwise. We are not measuring the exposure of the worker now when we do the fixed-station samples.

THE WITNESS: (cont'd.) It's a manager's need to know what is going on in his plant, and here the RDM-101 served that purpose because it measures dust, and dust is dust. You want to get rid of it, whatever it is.

It may, sure, if you are in the asbestos mill, it sure contains asbestos dust, but you want to get rid of the dust, not only the asbestos dust.

When you get rid of the dust, you also get rid of the asbestos dust, that's the point. The RDM-101 is there to measure the dust.

The APM is quite an interesting instrument. The acronym APM stands for ambient pollution monitor. It was firstly done to measure the dust in ambient air, like in the city of Toronto you might have an APM on the ceiling of a building, and it may be used there, but in the asbestos mines we used to measure the quality of what we call the return air. In the winter, the air that is processed within a mill may amount to between one million cubic feet a minute to four million cubic a minute in various plants, and that air that has been heated by the machinery, instead of rejecting it outside, is passed through filters and serves again in the air. It's rejected inside the building and the same air is used very often, with a little different makeup - new air everytime - maybe ten percent of the air in winter is makeup air.

I think it's too bad Mr. Pughs has gone, because he is the production man, he knows what the air was used for and I know, like, largely, forty percent of the air was used for environmental purposes, and sixty percent of the air was used for production purposes. The air used for production purposes was for getting the fiber out of the rock and getting, separating the various lengths of fibers.

But the APM, to come back to the APM, the APM

THE WITNESS: (cont'd.) is used in what we call the plenums, the dust plenums, outside the bags after the air has passed through the bags then the air is supposedly, it is supposedly cleaned, and we assessed that it is clean with the APM.

When the APM has a trend upward, or if there is a big leak and we see a very upward significant result with the APM, then we go with the Tyndallometer to see where that leak is. But using the APM on, I think it's every thirty-five minutes it gives a data, and you are looking at that data and you get...I think I have proposed figures showing a few data with the APM on it, again in table four, in exhibit number four. The example is given on page 239.

There is an example there that we see...we almost see a trend and we can almost predict that there is going to be a break in the filters. We see the wearing, like the black dots on figure six point eleven represent respirable dust, and we see the trend upward and then something breaks and it goes high up.

I just want you to look at the data. The data are in micrograms per cubic meter in the return air, and not in milligrams.

By the way, these instruments were installed and then the province arrived with a standard of point two zero milligrams per cubic meter for the return air...of respirable dust.

Here, the instrument also does total dust, but it's very similar to respirable dusts, except the measurements are higher, but they follow the same trend.

So that's about it for the gravimetric...what we call the gravimetric instruments, and they serve, as you see now, the purposes that are quite different from the purpose of the measurement of the exposure of the worker.

DR. UFFEN: Could I draw attention to two things

DR. UFFEN: (cont'd.) about this last one, the ambient pollution one.

THE WITNESS: Yes.

DR. UFFEN: It has a very, very much higher rate of flow of the air, nine liters per minute?

THE WITNESS: Yes, indeed.

DR. UFFEN: So is that four or five times the others?

THE WITNESS: It's five times the others, but it's built with another type of cyclone. It's a steel cyclone and this cyclone is made up..it's made so that nine liters per minute flow will separate the respirable from the nonrespirable parts of the dust. It collects more...we needed an instrument that collected more dust in order to get enough mass to be able to get the significant measurement.

Like, the more you get in, the more mass you are going to get of dust on your filter, the easier it's going to be for...to make an analysis on it afterwards.

DR. UFFEN: Presumably you can use it in regions where the dust levels are very much lower?

THE WITNESS: Well, in fact, this is it. We supposed that in dust plenums the dust level is the lowest in all the mill. It's the back...remember that the air that the instrument is measuring is returned to the workers. That air is going to be breathed...I don't know exactly what's right... but the workers are going to have that in their noses afterwards, so that air must come as clean as possible out of the bags.

That's why we have to assess the quality of that air all the time, and not on an irregular basis, and this instrument served that purpose.

DR. UFFEN: One more minor question. I noticed in the description of it...I happened to be reading it in tab one, but I think it's also in tab four...it said, "In order to

DR. UFFEN: (cont'd.) "prevent condensation, an electric heater assures a variation of about thirty degrees Fahrenheit in the temperature of the sampled air".

What does that do to the humidity, and what does that do to the fibers?

THE WITNESS: In fact it's only...if I recall well, if you are into the specification of the instrument and that specific point is, if you work in too-humid air, there is a chance that...there's a Venturi that's put into the instrument so that you always have the same flow rate, and that Venturi could easily be fogged up if humidity was present in that air. Okay?

The dust could clog, with with the water, on the flow temperature of the Venturi, and it could clog the filter and clog the apparatus, so the apparatus heats the air before entering...

DR. UFFEN: And it drys it out.

THE WITNESS: ..and dries it out.

DR. UFFEN: So you are not measuring the true ambient air?

THE WITNESS: We are not measuring...again, we are measuring milligrams per cubic meter. We are measuring gravimetrically and we don't want also to...there is another reason to it, too..we don't/a weight of excessive water on our filter. We started with a dry filter, and if the air is full of moisture, that moisture will, if it goes through all the time, it's going to go on the filter and it's going to be weighted, using the beta radiation attentuation, but still it's going to be weighted with the rest of the dust, as it is vapor...it's coming from vapor only.

DR. UFFEN: But we would be weighing water and dust?

THE WITNESS: Water and dust, that's it. And you don't want to weigh the water because it was present in the atmosphere as vapor, not as water.

In fact, it's a very nice little gadget on the instrument that prevents...in fact, not measuring the truth, just... you know? It helps you measuring the true thing that is in the atmosphere.

So that's it for the instruments, the gravimetric instrument that gave data readily. But now we may measure dust also gravimetrically, analyzing the dust. It has been tried before and even used on a regular basis in some other countries.

Now I want to talk about methods of analysis like infrared spectroscopy, the x-ray diffraction and titration.

MR. LASKIN: Q. Could I ask you just one question before you leave all this measurement, just so I understand it? Could you go to tab five for one second, which were the measurements that you actually made in Quebec, and let's just take the first page, the Johns-Manville Canada Inc. fixed stations, all stations.

First of all, what method was being used to take the measurements that are shown in this page?

THE WITNESS: A. One of the many membrane filter methods. Over the years, we changed. In 1970, I wasn't there. I started in 1976. Starting in 1976, I know for sure it was the NIOSH, what is called now the NIOSH-II method. Or even in 1976, it must have been the NIOSH-I method.

But in 1970, it was the membrane filter method as it was known then. I don't know in fact what membrane filter method was used then.

Q. All right. I take it...

A. I'm sure it was a regulatory method.

Q. Okay. I take it from the title at the top that

Q. (cont'd.) these were not personal sample measurements, these were fixed-station measurements?

A. Indeed, yes. They were there to see the improvement of the dust situation over the years in a factory...or this is for the mills.

Q. Can you...although the first category you've got is zero to two fibers per cubic centimeter, can you give us any idea today what the percentage of samples would look like if the category were zero to one fibers per cubic centimeter?

A. I don't know. I don't know. Look, from zero to one, you don't have so many, eh? You have point one because you start at point one. Anything below point one, you said below point one. So you start at point one, point two, point three, point four, and you only have ten chances between zero and one.

I don't know how many. I don't have the slightest clue.

Q. All right.

A. But these data exist, and they are public data. These could be examined by your Commission if need be. These are public data that are given to the inspectorate of the Quebec government, so it's not that I do not want to answer. I just can't remember. I could say a number, but it could be as false as anything.

MR. LASKIN: Q. Dr. Mustard has a question, but I just want to find out, are there equivalent data for personal sampling measurements?

THE WITNESS: A. Less, because we started personal sampling on a regular basis only in 1978, or even 1979.

DR. MUSTARD: I would just like to followup with a question on the table in tab five, which may not be...he may not be free to answer. But I was fascinated, I was going through all the examples that you had of fiber concentrations, about the fact

DR. MUSTARD: (cont'd.) that in some of the mines the shift to a low fiber concentration per cubic centimeter seemed to be faster than in other jurisdictions. If you look at the Bell Mine in tab five, the surface one, and look at the first Johns-Manville, and look at the readings for counts greater than ten fibers per cubic centimeter, and for fibers zero to two, the question comes to my mind as a rather fascinating phenomenon that some of them seem to shift into a reduction and end up in a higher fiber content more rapidly than others....just looking at the data.

But then we would have to assume they are all measuring it the same way, and were they in fact measuring it the same way in all those mines?

THE WITNESS: Yes, they were.

DR. MUSTARD: So the explanation for the shifting has to be due to other effects?

THE WITNESS: Yes.

DR. MUSTARD: Do you know why some shifted faster than others?

THE WITNESS: I have ideas, yes. The main idea is first they all produce asbestos, but they produce, in fact, different products. Some produce mainly long fibers, some produce... with a lot of fibers in the ore. In fact the asbestos as a product may be grouped in seven groups. Nowadays they produce what we call group number three, four, five, six and seven. They do not produce any group one or two.

Group number three is long fibers, group number seven is short fibers. While all the deposits do not have the same share of all these groups, some have more group number seven and six, some have more group number three and four, and some have more four and five than the others.

So, producing a different product, they have a different layout...it's the...generally it's the same thing in

THE WITNESS: (cont'd.) every mill, but they may have a different layout from one mill to the other mill because of the product that they are making.

The second reason is probably the main reason, but I should have told it first, is the age of the buildings and the difficulty of bringing the, of making the dust controls.

Some buildings are very new, some buildings are quite old, and the old buildings, there may be problems of space to put dust control equipment in place.

Also, in another very new mill there is no problem of space and it's all in the first design that the dust control equipment is going to be put, so this might be another reason. That's the second reason.

A third reason is the resources. Because they sell different products, they might have different resources available - and I mean human resources and I get into something that I don't know now, but it might be also financial resources. But this is only an assumption here.

DR. MUSTARD: But in essence they are all using the same measurements, so it's a very interesting example of variability, of trying to achieve control.

THE WITNESS: Oh, yes.

What we can see...in fact if we could have drawn a general, one curve for everybody, we see now that since 1970 they went generally from twenty to forty percent of their data between zero and two fibers per cubic centimeter, and now they are more than ninety percent, most of them nowadays.

DR. MUSTARD: Just the other intriguing exercise for me, and thinking about this and health effects, is that for Bell, which is at the back end, there is one list of fixed stations underground and fixed stations surface.

THE WITNESS: Yes.

DR. MUSTARD: It looks like the fixed stations underground is a far tougher area to try to gain control. Is that a fair assumption to make?

THE WITNESS: Yes. Yes, it is a fair assumption that it is very much tougher in an underground mine than in a surface, and in a mill. But I would be surprised to see a 1981 similar survey, because specifically at Bell they changed totally their mining method between these data we are taking in now...

DR. MUSTARD: Yes, and that data, I take it, is publicly available?

THE WITNESS: Oh, yes. Indeed. In fact, Mr. Casgrain, I don't know if it's still available, but these are part of what we call semiannual surveys that we use to put together for the provincial government in Quebec the...the last time I was there, that was the semiannual of May...was it May, 1980? When I went in March, 1980, from the mines, we were in the process of making the semiannual of May, 1980.

I don't know nowadays if they still do it. I didn't ask.

M. CASGRAIN: It's now annual.

THE WITNESS: Semiannual?

M. CASGRAIN: No, annual.

THE WITNESS: It's now annual.

DR. UFFEN: Is there any particular time of year... when you say annual, do you happen to know what time of year?

M. CASGRAIN: They report annually.

DR. UFFEN: Report annually?

M. CASGRAIN: There is a difference between reporting and what they actually do. I think we can go into that with Mr. Trudeau. It would be a report once a year now, but they actually check on a regular basis, almost on a day-to-day basis.

THE WITNESS: Yes, but the process of the semiannual

THE WITNESS: (cont'd.) or the process of making the semiannual was a specific process that we would do specifically during a certain length of time...

M. CASGRAIN: On fixed stations.

THE WITNESS: The fixed-station samples, specifically in the later years where we did...the semiannual, it lasted long to make it, maybe two months, but it was within those two months that all the semiannual data was taken...except for one place that they did the semiannual survey all year around....rather, not the semiannual...the annual survey all year around, and they would start in January, and all the data collected from May to May, let's say, would be included in that annual survey.

But all the other places, it would be a specific time that they would do it.

Is that all, because I would like to talk about, very briefly, very briefly, about the statistic notion of numbers.

MR. LASKIN: Fine.

THE WITNESS: In fact I may have...I should maybe have talked about that in the definition process, but I think it's an appropriate time to talk about that.

I want to say I'm not a statistician, but I use statistics sometimes, and using statistics there is one thing that we, again, we must know...we used to talk about averages, but the average of many data is a valid statistic only if we have a normal curve, a normal or what we call the Gaussian curve of distribution. The Gaussian curve of distribution is...

MR. LASKIN: It's harder to draw it than say it.

THE WITNESS: It's fairly okay, eh? Here you have the data, like the average - we'll call it M, and it may be X fibers per cubic centimeter. Here is the frequency, okay? How many times you add M, you may add it twenty-five percent of

THE WITNESS: (cont'd.) the time, but it's the data you have the most often, not only, but it's the data that fifty percent of the data is lower than, fifty percent of the data is higher than.

Also, when we talk about the Gaussian...I say Gaussian, but I'll write normal. It's the same thing. They are synonyms.

We may talk about the standard deviation and we'll label it S. These...well, the distance is S and the value here is M plus S, and the value here is M minus S.

What it means here is when we say that...when we use a statistic M, plus or minus one standard deviation, we get sixty-seven percent of the data. We are sure that we include sixty-seven percent of the data, and again they are the same height on both sides.

And when we look at two standard deviations, M minus Two S, and M plus Two S, we get ninety-five percent of the data are on hand.

So if we calculate an average and we say out of a sample with many measurements, we say average M plus or minus Two S, that means that the data that was used to calculate M, ninety-five percent of it will be within plus or minus Two S's. But we made the first assumption that we had a normal distribution.

Now in reality what is going on? In reality, what we have usually is, as the numbers go lower and lower for the actual concentration of dust in the workplace, let's say we add an X here, and this is the actual concentration and it turns around that number.

So what kind of distribution will we get? We will probably get something like this. Something like this. That means that we will have from point one for the membrane filter, because we never get less than point one, okay? We'll have less

THE WITNESS: (cont'd.) than point one, and then point two, point three, point four. And let's say we go out to two, okay, and then four, five, six...we have limited space available under X, and a lot of space, to infinity, over X, and we have a few large numbers here - like big X.

If we compute an average out of those numbers, this value here may have a great meaning. It may mean a lot, it may...if we compute the same average as we did before, and let's say it's a hundred here and compare with a series of Two, you will have an average of fifty.

Well, this number statistically, supposedly, if we had arrived at that, doesn't mean a thing. It's not a statistic, a valid statistic, because an average has only a meaning when you use it with a normal distribution.

That kind of distribution here...I didn't name it yet...but it's called a log normal distribution, and there are statistics used to describe briefly what happens here, and it's called a median. It may be called a Sichel estimator, or it may be called a geometric mean. They are close to a median. In fact, the median of this, of a data, you calculate the median as fifty percent of the data is lower, fifty percent of the data is higher.

Here, in the Gaussian distribution, the average...and let's talk about the median, let's call it M Star, that would be the median. They are equal in the Gaussian. But here, no. The median may be here, and the average may be here, or whatever.

But the average isn't mean. It overestimates for this type of distribution what is going on within that distribution, so what I want to say, briefly, is with low numbers and that is valid not only for asbestos, but for whatever contaminant, when we get into low numbers and we still talk about time-weighted average, we might have a statistical problem

THE WITNESS: (cont'd.) of what is a time-weighted average.

We can't deal......we are making a statistical mistake when we talk about averages. We should talk about medians or Sichel estimators, or things like that.

This is easy to deal with. It's called log normal. If you take the logarithms of all the data here, and put the logarithms into a frequency picture like that, you get this. Then you work at the logarithms. You take the average of the logarithms, and taking the answer, you come back to the estimators and...

MR. LASKIN: Q. The median figure, the figure where fifty percent of the measurements will be lower and fifty percent higher, will, with the log normal distribution, be lower than the average?

THE WITNESS: A. Not always, but in this case, yes.

Q. Not always?

A. Well, the log normal distrbution is skewed that way, but it maybe skewed the other way, too.

Q. But if you are talking about in the real world of the asbestos worlplace, I take it it will be skewed in the way that you put it?

A. Yes. I would suggest that the median would be always lower for our purpose, but this is only a suggestion. I would suggest that it would always be lower, yes.

DR. MUSTARD: You are talking about the distribution of a hundred separate measurements, is that correct?

THE WITNESS: Yes.

DR. MUSTARD: And that when you do the distribution, you find they are skewed and you can normalize them by taking the logarithm of the numbers, is that correct?

THE WITNESS: Yes.

DR. MUSTARD: That's what you are doing?

THE WITNESS: Yes. But then...

DR. MUSTARD: I have a fundamental problem with this in that your fiber distribution by size on most of the things I've seen suggests that it's probably a logarithmic distribution, which is going to affect your first estimate. Therefore, I guess in your fiber counting for your first count, your machinery makes no correction for the fact that you are only counting part of the fiber population, which is in itself probably a log normal distribution in terms of particle size, and the intriguing thing in my mind is, that's probably being reflected over in the actual distribution of single results that you get. I don't think you have to answer the question, but I think I understand the problem...in my simple-minded way, and it's rather interesting.

THE WITNESS: Well, you are attending two problems here.

DR. MUSTARD: Well, I have the same problem in the field in which I work. That is that your basic measurement of what you are measuring is a log normal distribution. When you do the unit measurements from that and then put all the numbers from all the measurements together, it carries over again. It's a compounding effect.

I think I understand what you are doing, and that's all I need to know. I don't think you have to straighten me out, because you can't.

DR. DUPRE: I might point out that Dr. Mustard frequently attacks several things simultaneously.

THE WITNESS: Because you are talking about length distribution, and we are talking about concentration distribution. There's two different things.

DR. MUSTARD: I realize they are, but in biology

DR. MUSTARD: (cont'd.) when you are up against the same problem where I do my measurements, whatever terms you use there is a relationship among them that is very hard to disentangle.

THE WITNESS: Well, that's the end of it to me.

Do you have any other questions?

MR. LASKIN: I'm certain my friends around the table will have some questions, Mr. Trudeau.

Have you people worked out some...?

M. CASGRAIN: Maybe because I'm the French relief from Montreal.

DR. DUPRE: You wish to go first? Please, M. Casgrain.

CROSS-EXAMINATION BY M. CASGRAIN

Q. Just a very few questions, M. Trudeau. You described in your curriculum vitae, and for our friends here in Ontario and for the record, perhaps we should review it in the other language that you and I speak from time to time, namely English, would you tell us what your functions are at the CSST, which is the new Workers' Compensation Commission?

A. Would it be interesting for the group to get a little bit of the structure of the CSST?

Q. Well, without going necessarily into all the details.

A. Without going into details? Okay.

Q. We really want to know what your responsibilities are in that area.

A. I'm doing that because it's a new commission, and the department for which I work is totally new, and has been put together since a year, about.

So there is the Commission, and the head of it. Under it there is the Inspectorate, there is the Administrative,

A. (cont'd.) there is the Compensation - they call it repatision in French. That's the previous Workmen's Compensation Board in Quebec. It is all here now.

There is a new outfit here, it's called the Prevention.

Okay, under the Prevention you have many organizations, and one is Formation and Information of the Workers and of our employees. One is called (French) , and her job is to go into the joint committees and institute the formation of the joint committees at the workplace.

Another one is...the (French) is under Prevention for a reason I don't know, but it's there.

There is a co-ordination here of everybody, and here there is something called...in French it's Programmes Etalon, in English it would be Programs and Standards.

Under the Programs and Standards there are various services. These are directions (sic), they are headed by directors.

So here you have the service of Medicine, you have the service of Safety, the service of Hygiene and a service of what we call La lession des affaires sociale. The main thing is to contract with the Health Department services and health at the workplace. I head that service here.

Q. Which is called what, again?

A. It's called the Service de Change Travail. It has no English name, but in English it would be Industrial Hygiene Service.

Our main duty in the first year was first to mount the department. When I arrived there, I was alone. Now we have fifteen professionals working within the department and our main duties were to build the tools that are going to be used for the Prevention. That is, we have a reportois des products toxic. It's a Reportery of Toxic Products that we are building on an on-line basis with the Health Department and industry.

A. (cont'd.) We have other tools like, we have a reportery of all the measurement instruments available for whatever contaminant. We have a reportery also...we are mounting a reportery for personal protection for whatever purpose - like it may be boots, or glasses, or whatever.

We are also responsible at the hygiene department for the guides that are going to be applied in industry. Like, we have a prevention guide called the Guide de la Borrison (ph.) de Programmes des Preventions. It's a collaboration of prevention programs, the guides to that. This is the responsibility for the employers to do, but we are providing guides how to do it, according to the law.

We are providing guides also, how to collect the data that you need to make a prevention program. It's called the Information System... how to collect it manually or with the use of a computer. That's up to the employer to decide, but we are having a guide of what he should put into that so that he is going to be able to build a prevention program.

We are also making a guide for the Commission itself in the regions so that they are able to analyze the prevention programs and to accept or not accept the prevention programs presented.

So that's for the tools and the guides, but we are also working and participating in two specific programs. We are working on noise, on vibrations, on silica, on asbestos and on lead, and we are working to present prevention programs for all these specifics, including health programs, including an environmental program.

Does that answer your question?

Q. Oh, it certainly does. Thank you very much.

Prior to...you stated as well in the beginning of your testimony that you worked for the Quebec Asbestos Mining

Q. (cont'd.) Association as a technical advisor, and prior to that, correct me if I'm wrong, you also said that you worked with the Beaudry Inquiry Commission which was set up precisely to define standards and look into the matters of health and safety at work for the worker in the mines and mills of Quebec - asbestos mines and mills of Quebec?

A. The asbestos plants.

Q. The asbestos industry in Quebec.

A. Yes.

Q. In that capacity you advised the Commission and worked with it in determining what these standards should be, is that correct?

A. Yes, I worked with the Commission, but I didn't advise anybody on the standards.

Q. You worked with the Commission in examining the instrumentation and the standards?

A. The instrumentation, yes, indeed.

Q. You subsequently...would you be good enough to tell us...I don't think you told us that in your evidence...what the norms are in Quebec, that were recommended by the Beaudry Commission and are now in force for the asbestos industry in Quebec?

A. Well, again, you are going to have...these are recalls. The norm is, in order to get an average...we have two standards. One is one in one regulation, and the other is in the mining regulation. Now I'm going to give you the mining regulation.

The standard is, in order to get an average of two fibers per cubic centimeter, you must respect inherently and constitutively four standards. One is, a maximum of five fibers per cubic centimeter; one is, point two milligrams per cubic meter in the return air of the plenum, or wherever there is return air; one is, between point two and five milligrams per cubic meter

A. (cont'd.) of respirable dust, wherever in the plant, and between point two and five is according to the amount of asbestos dust that there is in the air.

Q. Is it correct to state that in effect when you talk about fibers per se, the Commission and the government following suit on that established a MAC, what we call a MAC of five? That's maximum level, maximum number of fibers...

A. Yes.

Q. ...that could never be exceeded at any one time?

A. It is correct that it has expressed a maximum number of fibers of five fibers per cubic centimeter, but again, the question that I raised at the beginning is a question that is...I directed the question to you so that you could give me an answer to help me do my job in Quebec.

What I mean by that is, we are not sure what a MAC means and what an average means and what whichever term that is employed means, because it is defined or described so generally that it may be described, it may be used in whatever meaning you want it to be, to use it.

Q. But for practical purposes...?

A. For practical purposes it was understood while I was at the Quebec Asbestos Mining Association that the maximum was understood...that the maximum over the length of sampling time. That was understood. We understood it that way when I was working for the Quebec Asbestos Mining Association.

We never wanted a sample to be over five.

Q. Which meant that you had to be at no more than an average of two fibers, is that correct?

A. On the long-term basis, yes.

DR. DUPRE: The time of the sample was how long?

THE WITNESS: Most of the samples were taken on a ninety minute basis, during my time.

DR. DUPRE: So the maximum of five fibers would be

DR. DUPRE: (cont'd.) over ninety minutes?

THE WITNESS: Yes, indeed.

DR. DUPRE: Okay.

THE WITNESS: That is the understanding we had at the Quebec Asbestos Mining Association, but it's not written like that at all in the regulations. We might have to write it like that though. I don't throw that interpretation away at all. It might be the interpretation you want to give.

DR. DUPRE: It's written down as the maximum in the regulation how?

THE WITNESS: Like that - a maximum of five.

DR. DUPRE: Oh, but you don't know if that's over a year, ninety minutes or fifteen minutes?

M. CASGRAIN: Q. I think, M. Trudeau, perhaps we might sort of...not to prolong this...that the MAC of five was never to be exceeded at any time, with the result perhaps that you understood it to be two fibers per c.c. at all times, so that you would not exceed the MAC of five given the fact that you were using ninety minute intervals. Is that correct?

THE WITNESS: A. Yes, indeed. In fact this was the verbal interpretation we got from the Commissioners of the Beaudry Commission at that time when the Commission was held, but they never stated that by writing. It was omitted probably.

Q. Are you sure it wasn't their purpose?

A. Oh, yes, indeed.

Q. You were advising them, so perhaps you are the one who forgot it.

A. I forgot it, for sure.

Q. But then you came and worked for the QAMA as a technical assistant?

A. Yes, and I interpreted the standard the same way.

Q. And you were asked to help industry implement the recommendations of the Beaudry Commission?

A. Yes, part of it. Implement measurementwise.

Q. And if I may, just briefly, to summarize what I think I understood from your evidence, what in effect is being used by the industry, or at least was being used by the industry until you went to work for the CSST? You could say there were three main instruments - namely, the APM, which is used in the plenum for the return air, the RDM-101, which is used to monitor the dust concentration in the plant itself, and then the membrane filter method to determine the number of fibers per c.c. Is that correct?

A. You are forgetting the fourth, most important for the dust control engineer, the Tyndallometer.

Q. I was going to come...which is used as a check to do spot checking in the plant wherever you really...you may want to do this?

A. Yes, indeed.

Q. Would you be able to tell the Commission how many...before we get into that. Are you aware...and always we are talking at the time when you were with the industry...of the number of technicians used in each mill, in the Thetford and Asbestos area, to do the sampling?

A. It depended on the company, on the various plants, but everybody had more than one, specifically, and most of the companies had union members and an employer's representative making samples.

Q. And reading...?

A. Not together. They were not doing the samples together. In fact, you could not say who was who in the laboratory because they had their duty, their job to do, and they would do it very mingled. It was the laboratory personnel more than the union

A. (cont'd.) people or the employer's people.

Q. But it had been agreed that the union would provide one technician and the company would provide one, and they could work together?

A. It was not on a parity basis like that. In some companies they had one union representative and three or four employer's representatives. In other companies where they didn't need many people, they had a one-to-one basis, but usually if they need three they had one union and two employer's.

Q. You had occasion to meet with those people from time to time in your...?

A. Sure. In fact, they had to meet every month or so in order that we get the quality control of the dust measurement going.

Q. Did you find that they worked well together?

A. Surely.

Q. And that they were satisfied with the way things were being done?

A. Everybody from all the mines all together, worked well together...in the committee I was working with.

I didn't go everyday into their laboratory to see what was going on, this was not my job. But when I was calling a meeting and everybody would come, it was complete agreement and we would do the job as best we could as a group.

In the various laboratories, from what I know, it looks like...in the previous statement it looked like I never went to laboratories, but I spent most of my time in those laboratories...yes, they worked very well together all the time.

Q. Would you be able to tell us how many times or how the sampling was being done in each of the mines? Would you know?

A. Everybody had a sampling job to do everyday, but

A. (cont'd.) they did not sample all the time for asbestos dust. They had to assess the noise, too, and were mainly doing noise measurement and asbestos dust measurement. That was our main interest.

But they were doing also other contaminants that could have been present in the environment of the mills and mines.

Q. But dealing specifically with asbestos dust, how many times would there be sampling done or how would that proceed, generally speaking...by the technicians? Would they do it every day?

A. Yes.

Q. Would they cover the whole plant on one day, or..?

A. Oh, no. Never. They can't cover a whole plant in a day.

Q. So they would have a program of doing the whole of the plant over a period of time?

A. They have a schedule to respect and do every... and every laboratory had somebody that headed it and prepared a schedule accepted by the managers, and that was it.

Q. You spoke about the membrane filter method and about the RDM. Was the RDM used along with the membrane filter whenever sampling was being carried out?

A. Not all the time, but for the fixed-station samples, the fixed station were assessed by RDM's first. The first four minutes, the technician would stay there to see what is going on, and the last four minutes, and he would make an average of those two data.

But for the personal sample, nowadays very used, there is no use for the RDM there. It's a portable instrument, but it's not as portable to put it on the worker's shoulders.

Q. But you do sample the stations with the RDM, and the membrane filter would be used for personal sampling.

Q. (cont'd.) Would that be the technician who would be going from job to job with the membrane and taking the readings? Is that it?

I mean, is that how he would proceed?

A. Yes, I suppose so.

Q. I have to rely on you.

May I, just for a minute, go back to the... unfortunately, you have rubbed it off...but you showed something that looked like the Bell curve, and you talked about the median a little while ago, towards the end of your testimony.

A. Yes.

Q. What I would like to ask of you is, could you give me an example in figures of what would happen if I set, say, a median of two fibers? You would read on the one side, on the lefthand side, I presume, two minus down to, I suppose, minus one, as you said, minus one one, is that it?

A. No, no. There is no minuses in dust concentrations.

Q. But if you...looking at your example?

A. The less fibers...the minimum number of fibers you will measure using the membrane filter method is point one. Under point one, we say under point one, because we cannot rely on the method to measure under point one.

One would say, okay, why don't you sample for a long time and then you will get point zero eight if you sample for seven days, and it will be reliable because you will get a big mass of fibers on your filters.

Yes, indeed you would get a big mass of fibers. We also would get a big mass of other data that would hide the fibers from the microscopist, so it would be unreadable.

So the thing is that...what you want me to draw is with the two fibers per cubic centimeter...

Q. Mmm-hmm. And then one, and then zero five, if you could do that for me.

A. Oh, I could...this, again, is an assumption, but the higher the number, the more you are likely to get more and more a Bell shape. In 1970 when we used to say an average of twenty fibers or ten fibers, or I don't know how much, the average made sense. It was a statistic that made sense then, because we got close to...probably to a normal distribution when the data was high.

But nowadays, with the data low, we don't get a normal distribution. These type of curves I'm going to draw now exist with real data. They were shown by the Turner/Newell people in England at some symposium they had some years ago.

The more and more you have, the better control, the more and more you will have askew distribution.

Do I answer your question? Is this what you are asking for?

Q. Yes.

A. So if you have an average here, the average may mean something, okay? Here it means a little bit less, and here it means a lot less, and here it means nothing.

Q. So if you are talking in terms of averages, and if I talked in terms of say point five fibers per centimeter, what will happen with these curves?

A. An average of point five fibers per cubic centimeter is not a statistic. It's a false statistic. That's what I say.

I say if you talk about point five as an average, you are not talking...you may talk sense for some other purposes, but you are making a mistake, a statistical mistake, because you will never be able to build an average, a real average with a dust concentration around point five. Never, ever. You are going to

A. (cont'd.) maybe be able to build a median around point five, because you are sure going to get a log normal distribution around point five, if the real concentration would be around point five.

Q. You spoke in your evidence of the AIA membrane filter method which had been devised, and I think you told us that you sat on the committee that designed that particular method?

A. Yes. It was called the Dust Measurement Advisory Panel. It was...the chairman of that committee was Mr. Klaus Rowbuck from Germany. From many people...there was a guy from France, another one from England, another one from Australia, two people from United States, and...do I forget anybody? I think I have everybody...and me.

Q. Were there many meetings of that particular committee?

A. Oh, three or four times a year.

Q. Over what period of time?

A. For this, we were able to produce, after two years of work, three worldwide symposiums. We had a symposium where all those members were conveyed, the members whose names are written in the acknowledgement. We had the first symposium where we started that thing in Baden-Steinach in Germany, in 1978 or 1979, I can't remember the dates.

Q. When did this actually come out?

A. This came public, I think, in...no, I was still there when I had the first copy of it, so it came out in March, 1980...about, about. February, maybe or then...we were finished with it in January, 1980, because I remember translating it into French with my French partner in January, 1980.

Q. Isn't there another model that came out from the Central Reference System in England, recently?

A. This I read only about. Yes, indeed, there is

A. (cont'd.) another method that is proposed by the...some English organization called the Central Reference Scheme.

I didn't study the method. All I know is, it's different from the AIA method. My point on that is, the people that produced that new method have participated to the AIA, and they have agreed on the AIA method before, and I may say something harsh here, but I think those people are there to generate research for research, or argumentation for argumentation, and they are not at all generating new knowledge with their new method...of what I read of it. To me the reference method published by the AIA is still good, and is good for a few years.

I'm not saying that it's not going to become obsolete in some years, but what I'm saying is that it's the best we have now, and from what I read from the other method, I just don't like it.

I don't like that people generate research for research. It seems like we never end up with anything that will satisfy everybody. This makes a general...this satisfied everybody a year ago and I don't know why it doesn't satisfy everybody still now. In fact, it may not satisfy for reasons that I don't know, but it's rather intriguing to me.

M. CASGRAIN: I have no further questions. Thank you very much, M. Trudeau.

DR. DUPRE: I know you want to go shortly, M. Casgrain. If I could just interject one little question that comes out of your dialogue here, because M. Trudeau did say that he couldn't vouch that he was absolutely straight on with his memory on the standard.

I just wanted to ask this: Part of the Quebec asbestos standard, as I understand it...and I tried to write it down as fast as I could while you were speaking...does involve not fibers, but milligrams, for example, for respirable dust?

DR. DUPRE: (cont'd.) Point two to point five, I think, and I was just wondering...well, the question I simply wanted to ask was this: In your view, Mr. Trudeau, from your knowledge of the industry, do you believe that in devising asbestos standards, bearing in minds the kind of operations that are carried on not only in mines in mills, but for that matter in other kinds of manufacturing, do you believe that a standard should among its components have not only a minimum fiber count, but also have some minima, really, that are applicable to dust, measured in milligrams?

I ask this because I don't believe that the British have a component, a dust component in milligrams that are standard.

A. No, they do not.

But in my opinion, yes, I do believe in the standard both in milligrams and in fibers, because...but, again, the standard must state what the aim is of the standard. If you are looking only at the exposure of the worker, then you state only fibers per cubic centimeter. But if you are aiming also at the general situation dustwise in a plant, then you want to aim at milligrams per cubic meter.

I would like to just say a few words on that because previously I had said that I would talk about infrared spectroscopy. I don't believe I did.

It was believed when we set up that standard in Quebec that the development of the method by infrared spectroscopy was almost finished. In fact, that infrared spectroscopy method for analysis of the samples was already routinely applicable in Germany, where they were taking into account that all the dust seen was asbestos because they were in a manufacturing industry. All the serpentine dust that was seen was asbestos. Okay? Because the infrared can very easily distinguish between serpentine and any other kind of dust, but infrared spectroscopy does not

A. (cont'd.) permit you to distinguish between chrysotile and lizardite and intigorite. It does not permit to do so because this method permits you to...it measures the vibrating motion in the bond between the oxygen and the hydrogen, and these bonds exist the same in all serpentines.

So we made...the Beaudry Commission, when we made that proposition, we thought that...we went to Germany, it worked well, and we thought it was readily applicable in the Province of Quebec, which it was not because we had so much a problem with serpentine, which was not fibrous. So this part of the standard was never applied, really, because of the lack of a method.

See, a standard without a method.

X-rays, it's the same problem. X-rays...if we would have intended to measure the same dust by x-ray diffraction, we would have had the same exact problem of not being able to differentiate the lizardite from the chrysotile.

Now, to end that and say everything that I had announced, there is titration using PH change in the dust, and there is a researcher called Claude Barbeau, Dr. Claude Barbeau, from Laval University. He claims that he can distinguish now all the serpentines, one from the other, and his method is proposed to the Commission for which I worked - it's not there anymore - for the Commission for which I worked.

DR. UFFEN: And fibers from nonfibers?

THE WITNESS: Yes, yes.

DR. UFFEN: Yes?

THE WITNESS: Gravimetrically we will be...he pretends that he is able to distinguish the fibrous material from the nonfibrous material, analytically.

It may work, it may not work. It's a matter of looking at it and criticising it if it doesn't work, and if it works, well it might become the method that we want to use. We

A. (cont'd.) are not sure yet.

Are there questions?

DR. DUPRE: Miss Jolley, are you next, or Mr. McNamee?

Oh, counsel?

MR. LASKIN: I just wanted to clarify the record just in relation to the one comment, and I draw on Mr. Rowland's English experience to tell me, but as I understand it, Great Britain does have general dust levels which apply in all mining operations that it may have. Just so that we...

DR. DUPRE: In all mining operations?

THE WITNESS: Oh, yes, they have standards for...

DR. DUPRE: But in terms of what may..of the asbestos standard in Britain, of course, involves, indeed, because they don't have any asbestos mines, it involves nothing but nonmining...

THE WITNESS: Mmm-hmm.

DR. DUPRE: Are there general dust standards that have been applied in manufacturing or processing?

MR. ROWLANDS: Yes, Mr. Chairman, you do have general levels for people like sunglasses, etc.

THE WITNESS: But I was asking your question only for asbestos before.

MISS JOLLEY: I just have a few questions.

CROSS-EXAMINATION BY MISS JOLLEY

Q. The first one is, I am a little confused about the...I'm sorry...the 101. You mentioned when you were introducing it to us this afternoon, I thought you said it was being used for engineering controls, to identify leaks and things like that?

A. No, the Tyndallometer is used to identify leaks.

A. (cont'd.) The RDM-101 is a matter of...it's used mainly for the manager's purposes to know if his plant, his mill or his mine that he is managing is clean or not, and they were using the RDM-101 in order to get a quick answer on that.

It gives you an answer in four minutes, so it's easy for the technician to go and get the data everyday. He doesn't have to spend half a day taking the sample. He does it in ten, fifteen minutes, and he comes back...or he does it on every floor if the manager requires data for every floor. Things like that.

Q. In Quebec, you have the different standards. One doesn't preclude the other? I mean, you can't choose between those...

A. Oh, no. They are all concurrent. They all apply concurrently.

Q. I was fascinated by your description of the QAMA joint committee structure, and the actual union participation in the measuring. And this is of special interest to us because in fact the Hamm Commission pursued the idea of worker/auditors in that, and it was something we actually pushed for.

Are these people full-time, the union technicians? Do they work full-time?

A. Most of them, yes. Oh, yes. In fact they are, yes, in all the mines nowadays. Lake is full-time, Bell...yes, they are all full-time people.

Q. Right. Are they trained by the companies to do the actual testing?

A. Yes, they are. They are sent to courses and not only courses on asbestos, but courses on noise and whatever other point of interest to a technician in industrial hygiene.

In fact, we have an organization in Quebec similar to the AIHA - the American Industrial Hygiene Association. We are not a chapter of the American Industrial Hygiene Association, but

A. (cont'd.) we have an organization that have monthly seminars and it's funny to see that the asbestos mines people are there at every single seminar we give on any subject, and they come as a group, mostly. Most of the time, five to ten of them.

Q. The industry would pay for the lost time for them to go on the courses, etc., that's all...?

A. I don't know who pays for the lost time. I know they come, I know they get paid. I don't know if they are paid by the industry or by their union.

They might...I think they would be paid by the industry, okay? But I just think...I never asked anybody, by whom are you paid today.

Q. To be quite honest, that's an important question.

A. Yes, but you have to ask somebody who knows.

Q. I'm sorry, I'm in the wrong...the other part is, while they are working full-time as essentially worker/monitors or technicians in this field, they are being paid by the company, they are not paid by the union, is that right?

A. Oh, no, they are paid by the company all the time. That's their job now. From the day they are hired to do that, it's their job.

Q. Right, and I think...

A. They are not really hired by the company. They are named by their union.

Q. Oh, right. Right.

The other thing you made a specific point of saying, of course they can't cover the whole plant in one day, and I think that's an important point for us. We are restricted to one day of monitoring, or one day of inspecting a plant a month, and that was an important statement that you made, because they are very big operations.

A. Yes. Well, some are very big, some are smaller.

Q. Right.

A. I think Johns-Manville in Asbestos hires close to two thousand people. You may ask...there is a Johns-Manville man here.

M. CASGRAIN: I'm afraid he has left, so he can't answer any of your questions.

MISS JOLLEY: Q. Well, in fact we will pursue this because we are absolutely fascinated by...

THE WITNESS: A. It's from two thousand people to three hundred. So some are very big...well, big according to size, and some, they are not so big. Moyen enterprise, we would say in French.

Q. Can I ask you in the Quebec law is this a requirement, of worker/technicians, worker/auditors, in addition to your joint committees?

A. Yes, indeed. There is a new law that this Commission that I described before is the Commission on Health and Safety at Work. It is a new Commission that was named by the government to administer five laws, and within these five laws there is one law that is new, or rather new, it was voted in December, 1979, and it's called the Law on Health and Safety at Work, and better known as Bill 17 in Quebec.

That Act provides, yes, it makes it obligatory to have joint committees, and within the joint committee a labour representative is what we call a representant la prevention, and his job is to inspect or prevent leaks and sources of contamination or risk within the workplace.

Q. That inspection includes being able to use monitoring equipment?

A. Oh, yes. Not only that, but it's provided by regulation what type of equipment should be bought by the plants in the various types of industry - not only asbestos, but all types

A. (cont'd.) of industry.

Q. Clearly a training requirement would then go along with that?

A. The training requirement goes along with it. It may be given by the Commission itself with...I showed this, the Formation Information Department is in charge of organizing the training of those people that need it, all of the costs of the employer, if there is a cost there to it, pay the people and things like that.

Those regulations, I must be fair, are prepared, but they are not voted yet. We have a difficulty to make those kind of things voted. It's...there is a big change in the management of Health and Safety, and it brings resistance, as normal. But at least it's a written matter in an Act.

Q. I must congratulate you on your Act, too. I think there are a lot of other aspects in your Act that are quite excellent as well.

A. Do you know that Act? I have a copy of it here somewhere.

M. CASGRAIN: I think we are going to be really out of our depth if you start getting into the various...

MISS JOLLEY: No, I'm not going to.

THE WITNESS: I'm very comfortable with that Act, so...

M. CASGRAIN: So am I. I may interject, if you permit me, that the mining companies, in effect, put into force the joint inspection long before this new Bill 17 was put in. The companies themselves went out and arranged for the joint committees and inspections prior to Bill 17.

THE WITNESS: The joint committees were formed, but the law provides now for specific duties and specific powers. The joint committee is now responsible for naming the medical officer

THE WITNESS: (cont'd.) of the company. It's not the management that names the medical officer, it's the joint committee. It's provided in the law.

The joint committee is also responsible for the information program. It's also responsible for choosing the protective equipment which must be provided freely by the management.

MISS JOLLEY: Q. Freely?

THE WITNESS: A. Oh, yes.

Q. The management pays?

A. The management pays for the protective equipment, yes, indeed. That's provided by regulation, and again these regulations then go farther now than at first, and it has to go to a second lecture.

As I said, the Commission is very new. It's since 1979, we first had to build our personnel, and now we are going into the regulation business. But...and the institution business, but it's another...

Q. Perhaps we'll call you back in the next phase when we talk about enforcement and potential.

A. If you want to call somebody back to talk about Bill 17, I think there are better people at the Commission than myself to talk about it. Even if I feel comfortable, that doesn't mean I would be the best man to talk about it.

Q. Can I just shift off, and I don't want to de-emphasize that, because I thought that was a very important part of your testimony, but this morning you indicated to us that you certainly weren't here to make a case for either the membrane filter, phase contrast microscope technique versus TEM, but in some ways you did make a case against the TEM, and you didn't raise all of the shortcomings of the phase contrast microscope as well.

Would you agree that there are a number of

Q. (cont'd.) shortcomings of that technique as well?

A. No.

Q. You wouldn't agree?

A. In fact, I didn't want to make a case against TEM, and I wanted to make a case instead for the membrane filter method. I'm sorry if I gave a false impression.

For sure there are many...not many, some disadvantages of the membrane filter method. The disadvantages are that its resolution is not down...as a limit to point two five micrometers limit of detection. But it's not a shortcoming. You have to live with that index, and that's all.

To me all methods show an index of the concentration, and if a choice has to be made between all these indexes, the best choice is the membrane filter method. That's my point.

The membrane filter method has its limits. It doesn't have its shortcomings.

Q. We did have expert testimony that did suggest a great number of shortcomings last week, and that's why I...

A. Well, I don't agree with them, myself.

MISS JOLLEY: That's all I have to ask.

THE WITNESS: Thank you very much.

DR. DUPRE: Mr. McNamee?

MR. McNAMEE: I believe I only have one question.

CROSS-EXAMINATION BY MR. McNAMEE

Q. I understand maybe Mr. Laskin already asked you while I was out making a phone call, but with respect to the coefficient correlation...on some of these tests they are obviously only isolated tests, maybe once a day or once a week, is there any...do you have any variation plus or minus ten or twenty-five percent for seasonal variations or the fact that you

Q. (cont'd.) might be measuring at a time of the day when the dust conditions might not be representative...say if you are doing two measurements in the entire day, is there any factor you would say this is plus or minus twenty-five percent of what we consider the statistical average for the day, something like that?

Do I make myself clear?

A. Yes, but you talked about a coefficient of correlation. I didn't talk of any coefficient of correlation. I talked about the coefficient of variation.

Q. Variation, I'm sorry.

A. The coefficient of variation is for the same sample measured by the same technician, for the sample measured by various technicians.

Now we are talking about another subject. We are talking about, let's say, in fact what we are asking is the shape of the distribution over a day, what could it be. It could be anything.

Your suggestion of twenty to twenty-five percent during one day makes sense. It makes sense, it's not something that will happen everyday, but it may happen that you have a twenty to twenty-five percent difference, real difference, in dust concentration within one day. It may happen because of various reasons - change of the ore or change of the rate of production, or change of whatever, or wear of the equipment, or it may have been only also statistically on a random basis, the variation, that there might be a variation in the dust concentration.

But it is something different than...this variation is a real variation and not a variation between technicians.

I talked about variations between technicians before, and not between one sample and another sample.

Q. Yes. What you are talking about, the difference between, say, two samples measured by two technicians at the same

Q. (cont'd.) time, or by different instruments?

A. If you take two samples measured by two different technicians at the same time, they are two different samples. You mean two samples that are taken aside?

Q. No, I mean...I understand now what you said. I would understand that the more samples you take during the course of the week, you are closer to a mean or a median...

A. A median.

Q. ...the true median that you would get.

A. Yes. But again, I would like to make very clear that when I talked about coefficient of variation it was on one slide measured by various technician. It was the same single slide that was measured, and they arrived at between fifteen and twenty-five percent difference on that same single slide.

That's what I said, and I didn't say that the concentration in the plants was varying from fifteen to twenty-five percent. I don't think I ever said that.

Q. No. I'm sorry, I phrased it the wrong way.

One other question. In the personal membrane filter sample, if you use the same type of filter...say that with one sample you want to use the electron microscope and the other sample you are going to use your optical microscope, do you use the same type of filter or do you use a different type of filter?

A. You may use the same type of filter, yes, which is a nest of cellulose filters, millepore filters, but...

Q. If you want to get two..say you wanted to test your electron, one sample by the electron and one by the optical microscope, two samples taken by the same person at the same time, would you have two personal samplers or would you use a sampler filter for each one, or would you just...

A. No, on a filter you can make many types of analysis, on one filter, because you can always cut it. You don't

A. (cont'd.) need the whole filter to make all the analyses.

MR. McNAMEE: All right. Thank you very much.

THE WITNESS: My pleasure.

DR. DUPRE: Thank you, counsel.

Mr. Sampson?

CROSS-EXAMINATION BY MR. SAMPSON

Q. I guess I would like to start out by making sure I understand what this maximum concentration that is used in Quebec means. Does that mean that if a government inspector were to go into a mine and measure a worker, using a personal sample, for fifteen minutes and found that the concentration was in excess of...

A. Five.

Q. Is it five fibers per c.c.? That that would be the basis for an immediate judgement that that plant was out of compliance?

A. It's understood that way. It's not written that way.

Q. How is it written?

A. It's written (French description) and the maximum is not...it's written must...

M. CASGRAIN: Must comply with...

THE WITNESS: A. ...with the maximum concentration admissible, and that's what is written. The maximum concentration is not defined. It may be thought since the regulation was almost a textual copy of the ACGIH booklet, it's thought as being fifteen minutes maximum, yes.

Q. That's what the ACGIH booklet said?

A. Yes. But again, when I testified earlier, we said that we understood it for a duration of the sample time, so it was in the mining area..we never see that, a fifteen minute sample,

A. (cont'd.) because there is not enough dust most of the time to get valid data in fifteen minutes. So we...the inspectors and everybody, the time they choose is ninety minutes. Then they get some fibers on their filter that they can analyze, and it's thought that if they go above five for that sample, they are out of compliance, yes. At five point one they are out of compliance.

Q. As a practical matter, what does that mean that the average...for the average concentration that has to be maintained in the workplace, in order to be sure that at any given hour on any given day, at any time of the year, that somebody is not going to come in and find you at five point one or above, what average level do you have to maintain in the workplace in order to be reasonably sure that that won't happen?

A. With all the limits that an average has, as I said before...

Q. Taking all that into account, yes.

A. Okay. It was thought that a yearly average of two would permit you to...and now I'm making...this is all written in the Beaudry Commission Report...an average of two would permit... a maximum of five over one sample duration would permit an average of two, and two on a certain duration, but the certain duration is not cited. Again, this is a limit of the report. It's not said if we think yearly or monthly, or whatever. But in our understanding, when I was at the QAMA, it was a yearly average.

Q. Okay.

A. It's difficult to build an average anyway, with one sample a year, but a maximum and an average then becomes almost the same.

Q. Let me ask you a related question on that. You answered a question earlier about the use of combining...the advisability of combining fiber...a standard based on fiber counting

Q. (cont'd.) with a standard based on gravimetric measurement techniques...and that's what the Quebec standard does, it combines those two types of measurement.

Did you also say that the fundamental purpose of all of these individual standards that the MAC of five and the various gravimetric standard, is to get an average concentration in the workplace of two fibers?

A. Yes. This is the objective, yes, as stated in our regulations.

Q. Why did the Beaudry Commission feel as though they couldn't simply require, as many standard do, I think, that... simply set a standard saying that exposure shall not...that the average exposure shall not exceed two fibers?

A. Because they went into something else than exposure of the worker. They went into the dust control. When they expressed a milligrams per cubic meter standard, it's a dust control standard. It's not the exposure of the worker.

A worker that works two hours a day in a specific place may be exposed to dust counts so that on an eight hour basis he would not be...or on a ninety minute...he may work fifteen minutes, where in ninety minutes he would be out of compliance, let's say.

In fact, the milligraphs...this is not...it's badly stated. What I say is that where you have numerical fibers per cubic centimeters, it is thought that you measure the exposure of the worker. When you measure with...the objective that you pursue when you measure with gravimetric instruments, you pursue a quality control of the total plant without the men - the men being in or out, it's the same. You have to all the time respect that.

This is the way I think it should be interpreted, but again, because we have a similar problem with these definitions now, I have set up a committee within my department working with the

A. (cont'd.) inspectorate, as you saw. We are working with the inspectors, but we are not part of them, but now I have a committee in the Quebec Province with the inspectors. It's set up so that we define the words that we...and interpret them as we think they should be interpreted.

Q. I'm not sure whether...let me ask it again and see if it comes out more clearly to me. Are these requirements, let me just go back and read them - you said there's one of the Quebec requirements is a point two milligram per cubic meter standard for the return air?

A. Yes.

Q. Now, is that standard there because the Quebec or the Beaudry Commission, or the Quebec government, felt as though that was a safe or acceptable level, or is it there because they felt as though that requirement would help ensure that a two fiber per c.c. standard would in fact be achieved in the plant?

A. It has nothing to do with the two fiber per c.c. This standard is set up for the return air, and it is thought that the return air should be as clean as possible, specifically because it is returned to the workers.

The background measurement you'll get...in fact, we do fiber measurements in the plenum, and it's always below point one, or most of the time below point one, okay? So that standard stated in respirable dust - not in asbestos dust, but in respirable dust - is stated there so that the return air is as clean as it can be when it is returned.

Q. Okay. Another clarifying question. I'm not sure I followed the exchange you had a minute ago about the coefficient of variation.

You have given figures of about fifteen to twenty-five percent for the coefficient of variation for the counting aspect of the membrane filter method. Could you clarify exactly what the

Q. (cont'd.) counting aspect includes? And also where those figures come from?

A. Okay. The counting aspects, it's the comprehension of the diverse attributes we give to a fiber. You have a slide and you must count it. You must count the fibers longer than five microns, which have at that time when that...I made an experiment and when I made the experiment it was diameters under five microns, and not three microns. We had in mind all the judgements that we were supposed to have on split fibers and agglomerates, and everything.

Q. As specified in the AIA method?

A. Yes, that we find in the AIA method.

So, having that in mind we made a round robin, but it was not a real round robin. Every technician was in the same room and they had to examine all the same slides on the same microscope - same slides, same microscope - and we arrived at close...between fifteen and twenty-five percent difference as an average, as a coefficient of variation.

A coefficient of variation is defined as the standard deviation over the average, two statistics when you have a Gaussian distribution. So Guassian distribution was...

Q. Assumed?

A. ...assumed. Even if it wasn't really there, it was assumed for the purpose that we didn't know better, okay?

Q. So this was a very carefully-controlled experiment?

A. The experiment, yes, was carefully controlled. What was less controlled is the interpretation of the data.

We made one...the first report...that was the first time we had everybody together. We had a training going from one lab to the other lab, but then at one point we said that's it, we are going to have everybody together and measure the fibers on the

A. (cont'd.) same microscopes, everybody.

We got what we think was pretty good, between... that's it, close to twenty percent coefficient of variation, and that's what we aim at now that the people get permanent slides and things like that. We aim that on the permanent slides there never should be more than twenty percent, let's say, coefficient of variation after one round robin has been finished.

I know some other data have been published that show a higher coefficient of variation, but people are not...in those publications...people are not measuring the same thing and they have not been trained before where to start the counting, you know? Here, everything was set. They were always measuring the same field, even.

Q. But the broader, the higher coefficients of variation that you see in other published reports, and that Dr. Chatfield mentioned, for example, don't surprise you, do they, in light of the fact that you don't have right now a rigid quality control program to maintain consistency among laboratories?

A. It doesn't surprise me at all. In fact, I think it goes up to fifty percent when you have different trained... the technicians are trained differently, the membrane filter methods are different, and things like that. It may go up very high. We are talking about coefficient of variation and not range. The range may be even higher than fifty percent.

Q. But what do you mean by range?

A. Maximum less minimum. The maximum technician less the minimum technician is always higher than the coefficient of variation, because the coefficient of variation is a statistic built on standard deviation and the average.

Q. Divided by the average?

A. Right.

And the range is another statistic built on the

A. (cont'd.) maximum value and the minimum value you get.

Q. Oh, so that would cover the entire distribution?

A. It would cover the entire distribution, right. So it's always higher, but again, it's not surprising since everybody uses a different method, and since everybody also measures different types of slides.

Q. There would be additional variabilities built-in because of differences in sampling, for example?

A. Well, not in sampling, but in the treatment of the sample once taken.

Q. Okay. You mentioned a couple of times this morning, I think, that the membrane filter method now is completely different than what it was in the 1960's, when it was first introduced?

A. Yes.

Q. You mentioned a couple of reasons why that is. One is better quality microscopes. I guess they have better resolution or something?

A. Well, better optics. We call the lens now achromatic, that is not influenced by difference of wave length in the microscope. It's now truer than it was eleven years ago.

Q. You also mentioned that technicians are better trained, that the counting rules...

A. Oh, yes. Nowadays they do only that. There was a time when the technician would do a sample a year, or two samples a year, and they do more of it, they go to lectures at NIOSH in Cincinnati, they attend meetings, and they also talk to each other a lot. Not only are they better trained, but they are highly, probably, educated from the time...they not only learn their trade, but they understand it.

Q. Would it be...it sounds to me like both of those

Q. (cont'd.) factors, and I don't know whether those are all the differences that exist between the 1960's and the present, but the two factors you have mentioned would tend over a period of time, it sounds like, to result in higher fiber counts?

A. This is a qualitative...qualitatively, I would say sure.

Q. Would you have any guess on what that might be quantitatively?

A. I don't have. All I know is that from full field examination to a graticule, it went up four times, I think, and then from...I don't know. Probably again we are talking about fifty percent coefficient of variation with the technicians now, with several membrane filter methods. While you are introducing a time lapse now here, there might be a big coefficient of variation, but it is for sure that measurements made with the methods and with the tools and by the technicians of the 1960's would be quite lower than the measurements made today with what is called the membrane filter method, again, still nowadays.

Q. Okay.

A. But these are all assumptions. I think very fair assumptions and probably very much true assumptions, but who did the measurement, who did the comparison? Nobody.

Q. On page 223 of tab four, you are talking there, I believe, I hope, about the AIA method?

A. Yes. Well, this was written...this exhibit was written before the actual AIA method was published. So if you want to refer to the AIA method, I would urge you to refer to it, really.

Q. Well, I was just going to ask about something you say here. You say, "The method is presently being examined

Q. (cont'd.) "by an international team of experts to look critically at the proposal".

I was wondering whether that examination has been completed or...what international team of experts was looking at the method and how far have they proceeded in terms of their evaluation?

A. Well, that's it. I started to say before that there was a Dust Measurement Advisory Panel...six members, five to six members...and we met three times or four times a year, working on that.

The meetings were in order to write drafts, presented to experts worldwide. Those experts were invited to symposiums... we held three symposiums - one in Welan Steinach in Germany, one other in Washington, D.C. six months later, and a final one in Cannes, in France. They came from all over the world, all those people that are mentioned in the acknowledgement, and some of the people who are not mentioned in the acknowledgement were also asked for their comments, and they produced comments and suggestions to the Dust Measurement Advisory Panel that, with the help of those comments and suggestions, built this.

This final product is very much different from the first draft we had proposed to the international community.

Q. So the AIA method you are talking about in this particular paper is not the same thing that was finally adopted?

A. Not exactly, because this was from one draft, and this is the final thing. It's not...this...my paper there is not from the first draft. It's from one of the final drafts, but it's not the same as this exactly.

Q. Okay. But the international team you are talking about is really the Dust Measurement Advisory Panel, which was evaluating the drafts in order to produce a final

Q. (cont'd.) set of recommendations?

A. They were the comments and suggestions of the international community in order to make a decision. They were the decision makers, consensus makers.

Q. Has the AIA method been adopted in a the standards of any jurisdictions that you know of? I know you said that you didn't feel...

A. My answer is no, not that I know of.

Q. Okay.

A. But it may be. I don't know, in fact. I would like to see what is going on in Europe. Maybe those people here at the table know what is going on in Europe.

Q. I just have one last question, or subject.

During an exchange with Chairman Dupre, you talked about the idea of, if you had a standard that specified different levels for different fibers, that you could, once a year, go into a plant and determine what the mix of those different fibers is in a dust cloud and then assume that mix, for some period of time, absence of change in the process, and use the membrane filter method. When he appeared here, Dr. Chatfield suggested that there might be some circumstances where that kind of approach might not work. He said specifically there may be some process in the plant where you are using entirely crocidolite, for example, for which maybe you would set a lower standard, and to use that mix, that sort of weighted standard to that kind of operation wouldn't be appropriate.

I just wanted to ask you whether or not in doing this sort of annual assessment of the relative concentration of various fiber types in the dust cloud, whether you couldn't make that assessment on a process-by-process basis?

A. Sure. You have to use your judgement. You have to use your knowledge of the process. Exactly. Going from...

A. (cont'd.) exactly like you say...process to process. In French we have to describe by poste de travail. Poste de travail is a location, and in that location you make a judgement if it is all the same. If it is not all the same, then you divide that location into two parts. For sure.

There is a lot of...this science of industrial hygiene, it leaves part to judgement, as any other science, and you have to use your judgement. Sure. I agree with you.

I do not believe that Dr...in fact if Dr. Chatfield has said that, I do not agree, because we can go from process to process very easily...or assume a hundred percent crocidolite in that process without even making a measurement, and assume. If it's only crocidolite there, you have to assume a hundred percent crodidolite. You don't have to ask somebody that would charge you a thousand dollars per sample to tell you that it's crocidolite. You know it is.

Q. I guess I asked the question because I believe it has been proposed - perhaps it's in the Ontario government proposal - that where you have a mixed environment that you have to...that the lower standard would have to be complied with.

For example, if you had fifty percent crocidolite and fifty percent chrysotile, the entire process would have to comply with the more stringent crocidolite standard.

A. It's another option. I don't have to make a judgement on that. It's an option that is very...if they do make that choice, that's their choice.

Q. But it's not unfeasible to set a mixed or sort of a weighted standard in those kinds of situations?

A. I agree with you.

MR. SAMPSON: That's all I have.

DR. DUPRE: Thank you, Mr. Sampson.

Dr. Uffen?

DR. UFFEN: No, I had a good go this morning.

DR. DUPRE: Dr. Mustard? No?

Just one question, if I might. It's on the business of measuring milligrams of dust along with the asbestos fiber situation. Could I ask you this, and I realize the distinction that you have drawn, but what is going with the milligram standard in Quebec simply has to do with the quality of respirable air, because it's the return air.

I would like to ask you this, in an asbestos plant, all right, where you have...you are going to have particular reason to be concerned about your background air, your background is part of the situation...is there not something that can be particularly valuable in terms of measuring dust simply because, as I would understand it from a lesson I may not have digested wholly from another visiting professor, the measurement of dust is going to give you perhaps two things. Whatever is in that dust would include, I guess, the kind of fibers shorter than point one micron. It might also include, as I would understand it, some of the configurations of fibers that with optical microscopy may just, as I understand it, appear as a lump, at which point it may be discounted as a fiber altogether, as I understand it, or on the other hand there is another witchcraft measurement and you say well, maybe that's eight fibers, you know, because the assumption...

THE WITNESS: That's what is called the English proposition, the last English proposition, of that eight fibers.

DR. DUPRE: Right. If for your background air you are making a gravimetric measurement to meet some kind of a milligram standard, would it be so that what you at least would ensure is that in your respirable air, which is not to exceed, let's say, two milligrams, a certain potential amount of these phenomena, along with, of course, all the other things that make

DR. DUPRE: (cont'd.) up the dust would be controlled?

Of course there would be some asbestos particles or fibers that you will...or fibrils or whatever...

THE WITNESS: Yes, that would be accounted for...

DR. DUPRE: ...in the total volume of dust?

THE WITNESS: Sure. Yes, but again, I would like to comment on this answer - not give a blunt yes.

The comment is, the fibers that are short and thin do not account for much weight anyway. So that's first.

Second, the agglomerate or conglomerate, call it what you want, there might be a piece of actual, the actual volume, and yes, they do account...they make for a respirable part of it because the measurement is in milligrams per cubic meter. Those agglomerates, if they really exist in the atmosphere, they won't go through the dust separator. They will stop at the dust separator.

If they go through the dust separator - that is, if they are respirable - then they will be accounted for, yes, in the gravimetric counting.

DR. UFFEN: Could we call them globular clusters and join in with the cosmologists?

THE WITNESS: You may call them as you want, but define your word.

DR. UFFEN: I think if we call them globular clusters we will have all the cosmologists in the world worried.

DR. DUPRE: You've had a long day, Mr. Trudeau.

THE WITNESS: Yes.

(REPORTER'S NOTE: Brief exchange in French between the Chairman and the Witness.)

DR. DUPRE: Happy weekend, class. I understand,

DR. DUPRE: (cont'd.) counsel, we reconvene at ten o'clock on Monday morning. Is that correct?

MR. LASKIN: Correct.

DR. DUPRE: Thank you.

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THE INQUIRY ADJOURNED

THE FOREGOING WAS PREPARED
FROM THE TAPED RECORDINGS
OF THE INQUIRY PROCEEDINGS

Edwina Macht

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